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A COMPARATIVE STUDY OF THE PERFORMANCE OF MENTALLY HANDICAPPED AND INTELLECTUALLY NORMAL BOYS ON SELECTED TASKS INVOLVING LEARNING AND TRANSFER, DECEMBER 1, 1956 - NOVEMBER 30, 1957.

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THE RESPONSES OF EDUCABLE MENTALLY RETARDED CHILDREN AND INTELLECTUALLY NORMAL CHILDREN OF SIMILAR MENTAL AGES TO TASKS INVOLVING CERTAIN ASPECTS OF LEARNING AND TRANSFER OF THAT LEARNING WERE STUDIED. THE MAJOR OBJECTIVE WAS TO TEST THE HYPOTHESIS THAT DIFFERENCES IN ACHIEVEMENT AND INTELLIGENCE TEST PERFORMANCES BETWEEN THE TWO GROUPS TESTED ARE RELATED TO DIFFERENCES IN THE PROGRESS THEY MAKE IN LEARNING AND TRANSFER. THIRTY ENDOGENOUSLY MENTALLY RETARDED BOYS WITHIN THE IQ RANGE OF 50 TO 75 AND 30 BOYS WITHIN A NORMAL IQ RANGE (100-115) WERE MATCHED INDIVIDUALLY ON THE BASIS OF BINET MENTAL AGE (8, 9, AND 10 YEARS INCLUSIVE). THE MENTALLY RETARDED GROUP WERE SELECTED FROM THE SYRACUSE STATE SCHOOL, AND THE NORMAL BOYS, FROM AN INSTITUTIONAL SETTING. IN ADDITION TO THE DETERMINATION OF THE IQ BY INDIVIDUAL ASSESSMENT, EACH SUBJECT WAS SCREENED FOR ACADEMIC ACHIEVEMENT, AND ADEQUATE VISION AND HEARING. THE SIGNIFICANCE OF ANY DIFFERENCES BETWEEN THE GROUPS IN MENTAL AGE WAS EVALUATED BY MEANS OF THE T TEST. A SERIES OF TESTS, INCLUDING SUCH ITEMS AS CARD SORTING AND PAIRED ASSOCIATES, FURNISHED DATA FOR THE STUDY IN EVALUATING PERFORMANCES OF THE SUBJECTS. (GC)

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William M. Cruickshank, Ph. D., Project Director
Kathryn A. Blake, Ph. D., Principal Investigator

SYRACUSE UNIVERSITY RESEARCH INSTITUTE
OFFICE OF RESEARCH IN SPECIAL EDUCATION
AND REHABILITATION

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

In his critique of the research pertaining to some psychological problems in mental deficiency Sarason (40) demonstrated that there is a dearth of knowledge about many important problems in the field of mental retardation and a need for a great deal of systematic investigation. The educational implications of the mental age concept constitute one of these problems. Two points of view on this matter may be identified. The first is that, regardless of his intelligence level and chronological age, the nature and extent of a child's performance in intellectual situations are determined by his mental age level. The second is that expectations about intellectual performance cannot rest upon mental age alone, but they must be based upon a consideration of mental age in relationship to chronological age and intelligence level. For many years the first generalization has been accepted widely. In fact, such was stated explicitly by Hollingworth as long ago as 1920. Commenting on educational matters she maintained that

> . . . this fact that the feebleminded are different from average children not in kind, but in degree only, is of fundamental importance for education; for it follows that no mysterious or unique matter or method is necessarily required in the task of training them. They can learn the same things that other children learn, up to the limits of their capacity. We need not look about for unique 'physiological methods,' 'linguistic methods,' or 'medico-pedagogical methods,' nor may we hope for any special results from them. The feeble-minded differ from ordinary children only in amount of ability, not in the kind of abilities which they possess.

> A feeble-minded child, of whatever chronological age, if he has a mental level of seven years, is capable of acquiring the information that is acquirable by the average seven-year-old child. A feeble-minded child, of whatever chronological age, can do the work of the average second grade in public school, if his mental age is as much as seven years. He may be taught by the methods and with the materials suitable to children of about the age where he grades mentally (23, pp. 90-91).

In her discussion of relative learning ability she writes

> Mental age, not chronological age, is the basis of the learning curve. Ability to profit by instruction depends not on how long the individual has been in existence, but on the complexity and sensitivity of his nervous system. This complexity and sensitivity is represented by the concept of mental age, which shows the stage of intellectual growth attained. In children the nervous system becomes sensitive to a greater number of situations as it grows from year to year. This is true of all children, but the rate of growth and the ultimate limits of growth vary greatly from individual to individual. The kind and number of habits an individual can form at any given time are conditioned by the stage of mental growth which he has reached. Thus one of the first questions which a teacher needs to have answered about a child placed under her care is this: what is his mental age (23, pp. 181-184)?

The more recently developed contrasting point of view is exemplified in a statement by Goodenough. In a discussion of the relative merits of percentile scores and mental age values as methods of reporting intelligence test results she states

> . . . the idea that the mental age norms which have been worked out in the course of the original standardization of a test have some kind of final or absolute value is implicit in most of the interpretations of results obtained from different groups by the use of various tests. (With the percentile method) since comparisons are made only between individuals of the same chronological age, the implications resulting from assigning equal basic scores to individuals of very different levels of physical maturity and life experience are avoided. An imbecile of 15 with a mental age of 3 is a very different kind of human being from a normal child of three years even though he may happen to pass the same number of items on a certain mental test. Even his test score will usually show decided qualitative differences in the particular items passed and the kind of responses that are made to them (18, pp. 473-474).

If Hollingworth's contention is sound, and if all related variables are held reasonably constant, then regardless of the type of intellectual task involved, the performance of retarded and normal subjects of the same mental age should not differ significantly. On the other hand, if Goodenough's belief is sustained, then the groups should respond differently to different types of intellectual situations.

This issue is one of great importance to those engaged in the task of educating mentally handicapped children. Curriculum construction and methodological decisions are, to a great extent, contingent upon the characteristics, capacities, and potentialities of the affected pupils. Too often in the past educational planning for mentally handicapped children has had, as one of its bases, hypotheses about the intellectual functioning of these children which never have been substantiated by experimentally adequate research procedures. Ever increasing recognition of this situation has been demonstrated by the several investigations which have been conducted in this area within the last few years. That much still remains to be done was emphasized in a recent statement by Cruickshank. In a discussion of the results of two studies of relative academic achievement he writes

> Differences apparently exist (in performance in some aspects of arithmetic and reading achievement), although larger populations need to be studied for purposes of confirmation. What causes these differences? Further research of a comparative nature is indicated to study how mentally retarded children and normal children of the same mental age compare in those psychological characteristics which are inherent in the learning process and upon which the observed differences . . . are predicated (9, p. 122).

The present investigation represents such a study in the sense that an attempt will be made to seek some evidence concerning the role of some aspects of these basic psychological characteristics, i.e., response to situations involving learning and transfer of learning.

Review of the Literature

Pertinent research to the problem includes comparative investigations of the responses of endogeneous mentally handicapped subjects and subjects with higher intelligence quotients but similar mental ages to situations of an intellectual nature.[1] Examination of this research reveals that these investigations fall into three main categories: performance on psychometric scales, status on tests of educational achievement, and response to tasks involving learning.

Operationally, M.A. may be defined as a quantitative index representing the total number of items of an intelligence test which has been completed successfully by a subject. The basic concern implicit in most of the past research has been the determination of the meaning or implication of this quantitative index for the prediction of the responses of subjects of different intelligence levels to tasks of an intellectual nature.

In terms of frequancy, the greatest interest has been in item analyses of performance of mentally handicapped and higher intelligence groups on psychometric tests. Investigators in this area have sought to gain insight into the characteristic modes of intellectual functioning of these different intelligence groups. Their method has been to study the relative proportions of the different types of individual test items which contribute to the over-all M.A. which the subjects have in common.

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[1] The terms intelligence quotient, mental age, and chronological age will subsequently be designated I.Q., M.A., and C.A., respectively.

Analyses of the responses of retarded and normal subjects to the Goddard (1908) or Terman (1916) revisions of the Binet-Simon Scale have been reported by Wallin (46), Doll (12), McFaddin (34), Merrill (32), Doll, Phelps and Melcher (13), and by Martinson and Strauss (31). Comparison of the results of all of these studies reveals that unanimous agreement did not exist; however, it is possible to isolate some items which the majority of investigators found to differentiate between the groups. Subtests on which the normal subjects were superior to the retarded were: Superior Definitions, Repeating 5 Digits, Reverses 4 Digits, Ball and Field, Construction of Sentences, Rhymes, and Arranges Weights. The retarded children exceeded the normal on the following items: Vocabulary, Reading and Report, Date, Comprehension Questions, and Makes Change. Two pairs of investigators, Laycock and Clark (27), and Thompson and Magaret (30, 44), made similar analyses of responses to the 1937 Revision of the Stanford-Binet Scale. Laycock and Clark found evidence of significant differences on three subtests. Only one of these differences was sustained in Thompson and Magaret's later comparisons. In terms of number of subjects studied, the statistical analyses employed, and comprehensiveness, Thompson and Magaret's investigations appear to be the most adequate in this area. They found 60 items which reliably discriminated between superior, normal and retarded subjects. All of these differences were associated with extremely high levels of probability. The authors analyzed the nature of these differences in terms of three hypotheses. Briefly, the evidence failed to support the hypotheses that the items on which the performance of the retarded exceeded that of the higher intelligence groups were those judged to depend most heavily on past experience or those judged to require behavior defined as "rigid" by Lewinian theorists. On the other hand, the evicence sustained the hypothesis that those items on which the subjects of higher intelligence surpassed the retarded individuals were more heavily loaded with McNemar's (36) first factor which behaviorally can best be described as "brightness." In addition, Thompson and Magaret found that the retarded subjects consistently performed less adequately on rote memory items. The items on which these subjects were relatively more successful required manual manipulation versus entirely verbal response and involved test materials in contrast to verbal presentation.

Strauss and his associates (31, 42) and Bolles (1) were interested in the qualitative aspects of psychometric test performance. Strauss and Werner, and Martinson and Strauss observed that normal subjects consistently gave more _superior_ and _don't know_ answers to items on the 1916 Stanford-Binet. The responses of the retarded subjects were categorized more frequently as _nonsensical_, _ambiguous_, or _misunderstanding_. When she evaluated performance on a battery of conceptual tests in terms of degree of abstractness, Bolles found that retarded subjects responded most often in a concrete manner whereas the normal subjects could employ both concrete and abstract responses.

There were five quantitative studies of relative group response on other types of standardized psychometric tests. Although, in most cases, the authors obtained their results with different tests and, in every case, failed to report inferential statistics, it is possible to point out several types of tasks on which agreement existed between studies. Retarded subjects excelled normal subjects on the following: non-language tests (Taylor (43), Cunningham (10), Jones (25); tests involving motor manipulation of material (Taylor, Jones); digit symbol substitution tests (Chapman and Dale (5), Fox (16)). The normal subjects were superior on other types of tasks: word association tests (Taylor, Fox, Jones); picture, word, and sentence completion tests (Cunningham, Fox); tests requiring response to directions (Cunningham, Fox); and tests of attention and immediate memory (Taylor, Jones, Fox).

The pedagogical aspect of the problem has been another area of consideration. Researchers in this field compared the achievement test performance of groups of subjects which they held constant in terms of M.A. and allowed to vary in I.Q., C.A., length of school experience, and other factors. They used this procedure in order to inquire whether relative levels of attainment in different aspects of educational subjects such as arithmetic, reading, spelling, and writing are a function of M.A. level irrespective of other important attributes.

Two authors were concerned with relative increases in absolute achievement over a time span. Murdoch (33) assessed the status of a group of retarded children on two occasions which were one year apart and compared these scores to the normative data of the tests involved. The Stanford-Binet test results showed that over the period of a year the mean M.A. of the group increased 10 months; however, this figure has to be evaluated in terms of the 6-point positive variation which occurred in I.Q. Although the achievement test norms in some cases were for grades higher than one year subsequent to the initial grade norms, Murdoch reported that the increment in the retarded subjects' scores was not as large as that expected on the basis of the normative data. Davidson (11) studied relative growth in reading achievement shown by young children following a four and one-half month period of intensive reading instruction. She found that children with superior intelligence showed more improvement than children of average intelligence; in turn, the latter subjects showed more improvement than retarded children.

In addition to reporting rate of improvement Murdoch presented data pertinent to relative status at one period. Merrill (32) also, as one part of her study, employed the procedure of comparing scores obtained by retarded subjects to the test norms for children of the standardization population who had C.A.'s comparable to the M.A. level of the retarded. Merrill found that in arithmetic, reading, and spelling there were no significant differences between the over-all scores obtained by the retarded subjects and the normative data. Conversely, on tests different from those used by Merrill, Murdoch observed that the retarded subjects exceeded the norms in varying amounts; however, she did not evaluate these differences statistically.

The remaining studies of relative achievement consisted of direct comparisons of retarded and normal subjects. In terms of achievement on standardized arithmetic tests Jones (25), Merrill (32), Dunn (14), and Cruickshank (8) found that retarded and normal subjects did not differ in arithmetic computation. However, when they scrutinized the results of arithmetic reasoning tests, Cruickshank and Dunn noted that normal subjects significantly surpassed their retarded counterparts. Using both standardized and non-standardized testing devices Cruickshank made a further intensive analysis of additional aspects of arithmetic performance. His results indicated that normal subjects significantly excelled retarded subjects in the following: ability to solve abstract and verbal problems, ability to solve concrete problems in each of the four fundamental operations, understanding of the operation required in the solution of an arithmetic problem, isolating needed arithmetic facts from a body of extraneous information, solution and explanation of practical situations containing commonly encountered arithmetic terms and phrases, arithmetic vocabulary, and maturity of number apprehension. There was no significant difference between the performance of the subjects on problems which were stated in progressively more unfamiliar terms.

Jones (25), Merrill (32), and Dunn (14) investigated comparative reading achievement. Jones and Merrill found that normal subjects surpassed retarded subjects in reading comprehension. Dunn examined the reading situation in much more detail by means of a large battery of standardized and non-standardized tests. He reported that normal subjects exceeded retarded subjects in four measures of silent and oral reading, in ability to use context clues, and in performance during timed and untimed tachistoscopic presentations of words and phrases. There were no differences between the subjects in the following: frequency of faulty consonants, reversals, additions of sounds, substitution of words, omission of words; sound blending ability; increase in recognition of phrases and words on untimed over timed tachistoscopic presentation; number of fixations, number of regressions, or reading rate; and grade equivalents obtained on the Durrell-Sullivan Reading Capacity Test. The retarded subjects had significantly more faulty vowels, omissions of sounds, and words aided and refused; however, they had fewer repetitions and additions of sounds.

Performance on spelling tests received attention from Jones (25), Merrill (32), and Dunn (14). Jones observed that five retarded subjects scored higher on these scales than did five normal subjects, but he reported no significance figures. On the other hand, Merrill and Dunn obtained significant differences in favor of normal subjects on the same scales.

Jones (25) and Merrill (32) also disagreed about relative performance on writing scales. Retarded subjects surpassed normal subjects in Jones' investigation while the opposite occurred in Merrill's study.

The data obtained from assessment of relative learning and transfer performance also have furnished information about the ramifications of the M.A. concept. There have been only three studies of this type. All three involved an examination of the responses of retarded and normal subjects of approximately the same M.A. on two points: level of attainment with practice and the effect of this practice on subsequent similar tasks.

Colvin (6) was the first investigator in this area. Comparisons of the learning curves of five matched pairs of subjects revealed that in each case the normal subject made greater improvement with less variability than his retarded counterpart in response to a cancellation task. On the other hand, when Colvin followed up the direct learning study with one pair of subjects to determine whether the previous training facilitated cancellation of a different letter, he noted that the retarded subject showed the most transfer. He did not comment on the possibility that proactive inhibition or the reaching of physiological limits might have been influential in these latter results. Woodrow (49) used similar tasks in a much more extensive study of learning and transfer. He observed that both retarded and normal subjects showed improvement with practice but did not differ in the extent of this improvement. The retarded subjects showed somewhat more variability than the normal subjects but the difference was not significant. The subjects also did not differ significantly in performance on additional tasks of the same type following interpolated practice on the training task. Woodrow commented that on these latter tasks there was a great deal of individual variability in both groups; however, he reported no analysis of this variation. When the score increases attributable to repetition of the criterion tasks were controlled on the basis of increments shown by the non-practice control groups, the size of the transfer indices markedly decreased. A question arises concerning whether either of Woodrow's practice groups showed a significant amount of transfer. Woodrow dismissed this point as unimportant and did not perform an additional analysis of the problem. Another difficulty exists in Woodrow's study. He selected his normal subjects on the basis of an age-school-grade relationship. The intellectual characteristics of these subjects were not evaluated. It is unknown whether Woodrow's assumption that the subjects were of average intelligence and comparable in M.A. to the retarded subjects is tenable.

Although they were not concerned specifically with the comparative issue, Stevenson and Isco (41) furnished some information about discrimination learning and transposition. They reported that a group of retarded subjects took more trials to learn a size discrimination than did a group of normal subjects who were administered the same task by another investigator. The authors furnished no significance figures on the differences between these two groups. They made no comparison of the transposition performance of the retarded and normal subjects. However, it is pertinent to note that the retarded subjects did show a significant amount of transposition. In addition, there was a tendency for the subjects tested on stimuli removed four steps from the test stimuli to transpose less than those tested with more similar stimuli.

Statement of the Needed Research

Presented in the first section were two different points of view about the relative intellectual characteristics of individuals of similar M.A.'s, but different C.A.'s, and levels of intelligence. These two lines of thought were exemplified in statements by Hollingworth (23) and Goodenough (18). Briefly, Hollingworth maintained that these individuals would have similar intellectual capabilities and potentialities; Goodenough implied that they would not. For the most part, the majority of the investigations reviewed have been concerned with this issue. Hollingworth's expectation has not been confirmed by the results of these studies. Rather, some evidence has been obtained in support of Goodenough. Admittedly, a great deal of the past research on this issue can be questioned severely on the basis of experimental adequacy. In many of the studies there were insufficient controls for such factors as socio-economic status, physical and sensory impairments, institutionalization, etiological types, emotional adjustment, and other important variables. Very few of the investigators employed inferential statistics. However, there appears to be enough consistency in the results of these studies to justify the conclusion that mentally handicapped and normal subjects who have the same M.A. show both similarities and differences in performance on many types of intellectual tasks. The more experimentally sophisticated investigations by Thompson and Magaret (30, 44), Cruickshank (8), and Dunn (14) generally sustain the results of the earlier, less well-designed studies and thus lend credence to the conclusion stated immediately above.

The needed additional research might take several directions. In terms of the _status quo_ the above investigations should be extended to include larger populations of mentally handicapped and normal subjects of both sexes. Assessment of additional activities such as other aspects of the language arts and arithmetic areas, the social studies, the sciences, and the creative arts would be helpful in establishing more firmly grounded expectations about the educational capabilities of the mentally handicapped. Information about the comparative response of mentally handicapped and normal subjects to the various teaching methods and types of curricula would facilitate planning. The influence upon the observed differences of such factors as motivation, emotional and social adjustment, and socio-economic status with all of its implications in terms of social learning, motivation, and parental attitudes and influences would bear scrutiny. Finally, there is need for additional basic knowledge concerning the functioning of mentally handicapped and normal subjects in the field of phenomena which might be subsumed under the general term of learning. Limited aspects of the latter area constitute the concern [illegible] the present investigation.

Delimitation of the Problem

The results of the past research suggest that retarded and normal subjects who have similar M.A.'s show certain differences and similarities in performance on intellectual tasks. In terms of mean performance on these tasks the direction of the observed differences appears to be a function of the nature of the task involved. Retarded subjects tend to excell normal subjects on tasks which require motor manipulation of test materials. There is little difference between the subjects on tasks which involve mechanical or routine behavior which has been developed over a long period of time. Normal subjects surpass the retarded on tasks which depend heavily upon immediate rote learning responses and those functions which can be described behaviorally as "higher mental processes" or "brightness." In addition, some tendencies have been noted in relative variability and relative rates of improvement. The fundamental question which arises is this: will these relationships be reflected in direct learning and transfer of learning performance? The design of the present investigation represents an attempt to obtain some information pertinent to this question.

Assumptions

Such a design necessitates several assumptions. On the basis of the results of past experimentation and the opinions of informed authorities (24, 34, 35, 38, 45) in the field of learning and measurement it is assumed that

1. performance on achievement and intelligence tests is related closely to learning in previous situations

and serves as a basis for inferences about future behavior in response to tasks involving learning,

2. differences in performance on these instruments are indicative of possible differences in previous and future reactions to tasks involving learning,
3. selection can be made of learning tasks in which performance is based primarily upon such attributes as sensorimotor ability and brightness.

Hypotheses

Three sets of tasks were selected for the comparative study of direct learning and transfer of learning performance. Respectively, they involve learning sensorimotor responses, learning arbitrary rote associations, and discovering and applying an underlying relationship (or principle) upon which a correct response is based. If the above stated assumptions be tenable, the following hypotheses about comparative performance in these learning situations would seem logical on the basis of past research results and certain a priori considerations.

H_1: The mean performance of mentally handicapped subjects in direct sensorimotor learning is significantly superior to that of intellectually normal subjects with similar mental ages.

H_2: The mean performance of intellectually normal subjects in direct rote learning is significantly superior to that of mentally handicapped subjects with similar mental ages.

H_3: The mean performance of intellectually normal subjects in discovering a principle is significantly superior to that of mentally handicapped subjects with similar mental ages.

H_4: The variability of mentally handicapped subjects in the three types of direct learning performance does not differ significantly from that of intellectually normal subjects with similar mental ages.

H_5: The rate of learning of mentally handicapped subjects in the three types of direct learning performance does not differ significantly from that of intellectually normal subjects with similar mental ages.

H_6: The mean performance of mentally handicapped subjects in the transfer of sensorimotor learning does not differ significantly from that of intellectually normal subjects with similar mental ages.

H_7: The mean performance of mentally handicapped subjects in the transfer of rote learning does not differ significantly from that of intellectually normal subjects with similar mental ages.

H_8: The mean performance of mentally handicapped subjects in the transfer of a previously discovered principle does not differ significantly from that of intellectually normal subjects with similar mental ages.

H_9: The variability of mentally handicapped subjects in the three types of transfer of learning performance does not differ significantly from that of the intellectually normal subjects with similar mental ages.

Purpose

The specific purpose of this investigation is to evaluate these hypotheses in terms of data obtained when 30 mentally handicapped and 30 intellectually normal boys of similar mental ages are compared on the basis of their responses to the selected tasks involving direct learning and the transfer of that learning.

Definition of Terms

The following definitions of terms are employed in this investigation.

1. Mentally handicapped subjects--Those subjects who have intelligence quotients within the limits of 50 to 75 as measured by the Form L of the Stanford-Binet Test of Intelligence, 1937 Revision. Subsequently, these subjects will be designated the retarded subjects.

2. Intellectually normal subjects--Those subjects who have intelligence quotients within the limits of 90 to 110 as measured by the Form L of the Stanford-Binet Test of Intelligence, 1937 Revision. Subsequently, these subjects will be designated the normal subjects.

3. Mental age--A quantitative index representing the total number of items successfully completed by the subject on the Form L of the Stanford-Binet Test of Intelligence, 1937 Revision.

4. Direct learning--A change in performance which occurs under the conditions of practice.

5. Transfer of learning--A facilitation of performance which occurs following training on a similar task.

CHAPTER II

PROCEDURE

Experimental Design

Woodworth and Schlosberg's (48) Plan IV for the assessment of transfer was considered to be the most appropriate paradigm for the present investigation. They present this plan schematically as follows:

Experimental group learns task A. . . learns task B
Control group . . . . learns task B

When this plan is used it is necessary that the experimental and control groups be equated on the basis of initial learning performance or other highly related variables. Since three different types of tasks were being employed, matching on the basis of learning performance demonstrated on a pretest was not considered feasible. Instead, it was decided that the best procedure for equalizing the experimental and control groups would be to match the subjects individually on the basis of three variables: mental age, chronological age, and intelligence quotient.

Consideration of the above paradigm in terms of the comparative purpose of this study led to the development of the following design:

Learning Series	Transfer Series
Normal experimental group	Normal experimental group Normal control group
Retarded experimental group	Retarded experimental group Retarded control group

Thus, four subgroups of subjects were required; viz, a normal experimental group, a normal control group, a retarded experimental group, and a retarded control group. It was necessary that the subjects be matched individually in the following manner: the subjects in the two experimental subgroups had to be matched in terms of mental age but allowed to vary in chronological age and intelligence quotient. The same was necessary for the subjects in the two control subgroups. The subjects in the normal subgroups had to be matched in terms of three variables--M.A., C.A., and I.Q. The same was true for the subjects in the retarded subgroups.

The above model was employed in the administration of three different tasks. Therefore, the experimental subjects were exposed to the three direct learning and the three transfer of learning forms of the tasks, while the control subjects were presented only the three transfer of learning forms.

Subjects

Selection of the Subjects

Criteria for selection

Selected for inclusion in the present investigation were white, male subjects who satisfied the following requirements:

1. Revised Stanford-Binet M.A's. within the limits of 8 through 11 years inclusive;
2. Revised Stanford-Binet I.Q's. within the limits of 50 through 79 inclusive (retarded subjects) or within the limits of 90 through 110 inclusive (normal subjects).

3. residential placement for at least 6 months;
4. absence of uncorrected physical or sensory impairments;
5. academic achievement of at least second grade level;
6. absence--as judged by the residential social worker, the teacher, and the investigator--of any major emotional disturbance which might be detrimental to performance on the tasks.

Procedure for selection

The retarded subjects were selected from the population of the Syracuse State School, Syracuse, New York. The Syracuse State School, an educational and training center, is exclusively for educable mentally retarded children whose educational needs cannot be met in their own communities or whose parents are unable to give them adequate care and supervision. The emphasis at the school is on preparation for return to the community at a suitable age. Thus, relatively short term placement is the rule.

The normal subjects were drawn from the Elmcrest Children's Center and the House of Providence, Syracuse New York, and St. John's and St. Joseph's Home, Utica, New York. These residential facilities serve children whose parents are deceased or unable to care for them adequately. The children attend public and parochial schools in the local communities.

After an initial conference with the investigator the social workers at the participating institutions prepared lists of prospective subjects. These lists included all white boys at the

Syracuse State School who fell within the 12 to 17 C.A. range and who had previous Stanford-Binet I.Q's. between 50 and 80. The initial list of normal subjects included all white boys in the three homes whose C.A's. fell between 7 and 12 and who either had previous Stanford-Binet I.Q's. between 85 and 115 or, in cases of no previous psychometric data, whose school grade placement was within plus or minus one year of their C.A. expectancy.

The institutional and school records of each of the boys were examined. Automatically excluded from further consideration was any boy whose records contained notations of gross physical or sensory impairments, evidence during the last two years of severe emotional problems, or records, as of the preceding June, or academic achievement below the second grade level. Conferences were held with the social worker, the teacher and/or the school nurse to obtain information related to the above factors which might not have been noted in the child's records.

The potential subjects remaining after the initial screening were examined individually with the Form L of the Stanford-Binet Intelligence Test, 1937 Revision.

Matching

From those whom the above cited psychometric examinations revealed to have I.Q's. within the appropriate limits were selected the subjects to form the four groups required by the experimental design; namely, the normal experimental, the normal control, the retarded experimental, and the retarded control. (Subsequently, these groups will be designated the NE, NC, RE, and RC groups, respectively.) The subjects were assigned to the four groups in such a way that each subject in the normal or retarded experimental groups had a counterpart in the respective control groups who was similar in M.A., C.A., and I.Q. Simultaneously, each individual in the NE group was matched in terms of M.A. with a subject in the RE group; similarly, the subjects in the normal and retarded control groups were matched on the basis of M.A.

The basic information about the characteristics of the subjects in the four groups may be found in Table 1. There were 15 subjects in each group. The M.A., C.A., and I.Q. data for the NE and NC subjects appear in columns 2 and 3 respectively. Column 4 is composed of the differences between each matched normal pair on all of the variables. Columns 5, 6, and 7 contain similar information about the RE and the RC subjects. Column 8 contains the differences between the normal and retarded experimental subjects while the differences between the two control groups of subjects appear in column 9.

Examination of columns 4, 7, 8, and 9 reveals that discrepancies in M.A. as large as 5 months occurred only four times, and the rest of the matchings were within 4 months or less. In cases in which C.A. and I.Q. were matching variables, the largest difference in C.A. was 12 months; however, with a few exceptions most of the C.A. deviations were less than 6 months. Similarly, other than one 9-point and one 10-point deviation the I.Q. differences ranged from zero to 5 points. On the other hand, in those instances in which C.A. and I.Q. were not matching variables, the differences exceeded 30 months and 14 points, respectively.

TABLE 1

MENTAL AGES, CHRONOLOGICAL AGES, AND INTELLIGENCE QUOTIENTS OF THE SUBJECTS IN ALL GROUPS

Variable	(1) Pair	(2) NE	(3) NC	(4) NE-NC	(5) RE	(6) RC	(7) RE-RC	(8) NE-RE	(9) NC-RC
M.A.[a]	1	137	140	-3	137	139	-2	0	1
C.A.[a]		138	137	1	200	195	5	-62	-58
I.Q.		99	102	-3	76	77	-1	23	25
M.A.	2	134	137	-3	130	134	-4	4	3
C.A.		124	132	-8	182	183	-1	-58	-51
I.Q.		108	104	4	75	77	-2	33	27
M.A.	3	138	135	3	135	131	4	3	4
C.A.		149	141	8	184	180	4	-35	-39
I.Q.		93	96	-3	77	76	1	16	20
M.A.	4	131	133	-2	128	130	-2	3	3
C.A.		125	122	3	182	184	-2	-57	-62
I.Q.		105	109	-4	74	74	0	31	35
M.A.	5	128	129	-1	128	130	-2	0	- 1
C.A.		138	139	-1	201	204	-3	-63	-65
I.Q.		93	93	0	71	72	-1	22	21
M.A.	6	128	125	3	129	128	1	- 1	- 3
C.A.		134	137	-3	175	182	-7	-41	-45
I.Q.		96	91	5	76	74	2	20	17
M.A.	7	125	123	2	123	124	-1	2	- 1
C.A.		116	115	1	165	169	-4	-49	-54
I.Q.		108	107	1	76	75	1	32	32
M.A.	8	117	123	-6	119	119	0	- 2	4
C.A.		131	132	-1	162	160	2	-31	-28
I.Q.		89	93	-4	74	75	-1	15	18
M.A.	9	125	120	5	121	116	5	4	4
C.A.		119	127	-8	204	193	11	-85	-66
I.Q.		105	95	10	67	64	3	38	31
M.A.	10	118	118	0	116	118	-2	2	0
C.A.		108	112	4	169	170	-1	-61	-58
I.Q.		109	105	4	70	72	-2	39	33
M.A.	11	114	114	0	117	116	1	- 3	- 2
C.A.		124	127	-3	183	180	3	-59	-53
I.Q.		92	90	2	67	67	0	25	23

TABLE 1 -- Continued

Variable	(1) Pair	(2) NE	(3) NC	(4) NE-NC	(5) RE	(6) RC	(7) RE-RC	(8) NE-RE	(9) NC-RC
M.A.	12	109	113	-4	111	114	-3	-2	-1
C.A.		108	103	5	174	180	-6	-66	-77
I.Q.		101	110	-9	66	66	0	35	44
M.A.	13	105	101	4	109	104	5	-4	-3
C.A.		96	92	4	185	184	1	-89	-92
I.Q.		109	110	-1	62	59	3	47	51
M.A.	14	101	98	3	104	101	3	-3	-3
C.A.		110	110	0	155	167	-12	-45	-57
I.Q.		92	89	3	67	62	5	25	27
M.A.	15	95	97	-2	98	101	-3	-3	-4
C.A.		103	101	2	183	182	1	-80	-81
I.Q.		92	96	-4	56	58	-2	36	38

[a] M.A. and C.A. are stated in months in all cases.

Description of the Groups

Status of the groups on the matching variables

Information concerning the status of the groups on the matching variables is contained in Table 2. The mean M.A. of all four groups of subjects was 10 years 0 months. Both normal groups had mean C.A's. of 10 years 2 months. The corresponding values for the RE and RC groups were 15 years 0 months and 15 years 1 month, respectively. The normal groups had mean I.Q's. of about 99; the retarded groups, 70. In no case did the standard deviation of any variable appear to be extreme.

TABLE 2

STATUS OF THE FOUR GROUPS ON THE MATCHING VARIABLES: MENTAL AGE, CHRONOLOGICAL AGE, AND INTELLIGENCE QUOTIENT

Group	Mental Age (Years-Months)			Chronological Age (Years-Months)			Intelligence Quotient		
	Range	$\bar{X}$	S.D.	Range	$\bar{X}$	S.D.	Range	$\bar{X}$	S.D.
NE	7-11 to 11-6	10-0	1- 1	8- 0 to 12-5	10-2	1- 3	92-109	99.40	7.37
NC	8- 1 to 11-8	10-0	1- 2	7- 8 to 11-9	10-2	1- 3	89-110	99.33	7.68
RE	8- 2 to 11-5	10-0	0-11	12-11 to 17-0	15-0	1- 2	56- 77	70.27	6.71
RC	8- 5 to 11-7	10-0	0-12	13- 4 to 17-0	15-1	0-11	58- 77	69.87	6.63

__Comparison of the groups on the matching variables__

Before the experimental testing could be initiated, the four groups had to be compared on the matching variables. In other words, it was necessary to evaluate the observed differences statistically in order to insure that the conditions required by the experimental design obtained. These conditions were that:

1. the mean difference in M.A. between the normal and retarded experimental subjects and between the normal and retarded control subjects did not differ significantly from zero;
2. the mean differences in C.A. and in I.Q. between the normal and retarded experimental subjects and between the normal and retarded control subjects did differ significantly from zero;
3. the mean differences in M.A., C.A., and I.Q. between the normal experimental and control subjects and between the retarded experimental and control subjects did not differ significantly from zero;

4. the variances in all comparisons were homogeneous.

The t-test for correlated means and Snedecor F test of homogeneity of variance were used in the above analyses. The criterion for rejection of the null hypothesis was, in all cases, the .05 level of significance.

Table 3 includes data pertinent to the required comparisons. Inspection of the results of the statistical analyses employed reveals that all of the necessary conditions were fulfilled. Therefore, there appears to be justification for the following inferences. While they showed non-chance differences in mean C.A. and mean I.Q., the normal and retarded experimental groups and the normal and retarded control groups were homogeneous in terms of mean M.A. The two normal groups and the two retarded groups were homogeneous in terms of mean M.A., C.A., and I.Q. The groups were homogeneous in terms of the variances of all characteristics on which they were compared.

Tasks

Criteria for Selection of the Tasks

The characteristics of the tasks selected were determined by a number of factors. Two aspects of the purpose were important. First, an attempt was being made to assess the responses of subjects who had different I.Q's. but similar M.A's. to situations in which successful performance was dependent primarily upon different kinds of activity; i.e., learning sensorimotor responses, learning arbitrary rote associations, and discovering and applying an underlying relationship (or principle) on which a correct response is based.

TABLE 3

COMPARISON OF THE GROUPS ON THE MATCHING VARIABLES: MENTAL AGE, CHRONOLOGICAL AGE, AND INTELLIGENCE QUOTIENT

	Mental Age (Months)		Chronological Age (Months)		Intelligence Quotient	
	Normal Experimental Group--Retarded Experimental Group					
	NE	RE	NE	RE	NE	RE
$\bar{X}$	120.33	120.33	121.53	180.27	99.40	70.27
$\bar{D}$	0		58.74		29.13	
t			13.32***		12.29***	
s^2	177.67	128.52	219.98	202.78	54.54	45.28
F	1.38		1.08		1.20	
	Normal Control Group--Retarded Control Group					
	NC	RC	NC	RC	NC	RC
$\bar{X}$	120.40	120.33	121.80	180.87	99.33	69.87
$\bar{D}$	.07		59.07		29.47	
t	.093		14.06***		11.74***	
s^2	190.54	143.38	238.88	128.41	58.95	43.64
F	1.33		1.86		1.34	
	Normal Experimental Group--Normal Control Group					
	NE	NC	NE	NC	NE	NC
$\bar{X}$	120.33	120.40	121.53	121.80	99.40	99.33
$\bar{D}$	.07		.27		.07	
t	.82		.23		.057	
s^2	177.67	190.54	221.27	238.88	54.54	58.95
F	1.07		1.08		1.08	

TABLE 3--Continued

	Mental Age (Months)		Chronological Age (Months)		Intelligence Quotient	
	Retarded Experimental Group--Retarded Control Group					
	RE	RC	RE	RC	RE	RC
$\bar{X}$	120.33	120.33	180.27	180.87	70.26	69.86
$\bar{D}$	0		.60		.40	
$\underline{t}$			.43		.74	
s^2	128.50	143.46	202.78	128.41	36.93	43.86
F	1.11		1.58		1.18	

***Significant at less than the .001 level

Second, it was not the purpose of this investigation to verify the phenomenon of transfer; rather, an attempt was being made to compare the responses of the subjects in the two groups to situations involving direct learning and transfer of that learning. For that reason, a selection was made of tasks in which the stimulus and response components could be manipulated in such a manner that it could be expected on the basis of previous research and the theory of stimulus generalization that transfer of learning would occur to such an extent that it could be assessed (35, 45, 48). In addition, there were a number of practical requirements which had to be considered in the selection of the tasks. Some of these are the following:

1. the activity had to be interesting to the subjects.
2. while the activity had to be relatively novel, it could not be so out of the realm of experience of the subjects that its strangeness would create a disturbing factor.

3. performance on the tasks could not be so time consuming that participation in the investigation would make unreasonable demands on the time of the subjects who were currently engaged in academic work.
4. the activity had to be such that an adequate sample of the subject's performance could be obtained before fatigue occurred.
5. the activity had to be such that subjects widely varying in C.A. and I.Q. all could respond with some improvement of performance; i.e., it had to be neither too hard nor too easy.
6. the equipment and/or test materials had to be such that they could be moved from location to location and used in rooms with no special facilities; i.e., the material had to be taken to the subjects since it was not possible to bring the subjects to a central testing place.

The research and theoretical literature on learning and transfer of learning were reviewed extensively and a large number of tasks was considered. Finally, it was decided that the purpose and requirements of the present investigation would be realized best by the selection of tasks hereinafter designated as the card sorting, paired associates, and principle tasks.

Card Sorting Task

The learning series of the card sorting task consisted of sorting 32 cards bearing four designs which were assumed to be novel and meaningless to the subjects into four boxes bearing label cards corresponding to the four basic designs. The transfer series required sorting the 32 cards of the transfer condition into boxes labeled with cards bearing the transfer designs. The position of the boxes in the learning series was rigidly maintained in the transfer series. In addition, each transfer label card was put on the box occupied by its learning counterpart.

Materials

The four designs of the learning series were selected from the group of 13 standard forms developed by Gibson (17, 19). Twelve replications of each of these designs were printed in black ink on conventional (face side blank) playing cards by means of the silk screen printing process. All designs were 1 3/8 by 1 1/4 inches in size; the cards were 3 1/2 by 2 1/4 inches.

The designs of the transfer series consisted of variations of the four designs of the learning series. On the basis of judgmental and experimental evidence Gibson ranked these variations as being of second degree similarity to the learning series designs. Twelve replications of each variation also were made by the process described above. The measurements of the designs and the cards were identical with those used in the learning series.

Each of the four boxes was 5 by 4 1/4 inches in size. They were painted black on the outside and grey on the inside. The boxes were secured 2 inches apart on a single board. The lid of each box was fixed in a position in which it slanted outward at about a 75-degree angle. On each of these lids was a slot in which the label cards could be placed.

The two sets of cards consisted of four parts--4 label cards, 4 demonstration cards 8 practice cards, and 32 task cards. Pictures of the materials used in the card sorting task are contained in Appendix A.

Procedure

Learning series.--The subject was introduced to the learning series by a demonstration with four cards that each card was placed in the box to which was attached a label card of the same design. Then he was given eight practice cards to sort into the correct boxes. When he did this accurately and was able to verbalize what he was supposed to do, he was shown the stop watch and told that his performance would be timed. Next he was given the full deck and told to sort the cards as rapidly as possible. In addition, he was instructed to try not to make errors, but if he did so, not to attempt to rectify them even though they would be counted.

A trial consisted of the sorting of all 32 cards. The response measure was the time required to sort all of these cards. Time was taken to .1 of a second from the time that the first card reached the box until the last one was placed. Between trials the subject was given a 3-minute rest period. During this interval the time was noted, the cards were removed from the box, and the deck was reshuffled. The cards were shuffled by the following procedure: the deck was halved and shuffled by hand three times; next the cards were sorted into six piles with no card being placed on top of one of similar design; then the cards were gathered together and inspected to insure that no two cards bearing the same design appeared consecutively. The subjects were given five learning trials. Following this they were given a 5-minute rest period. During the rest period the label cards for the transfer series were substituted for their respective learning counterparts.

Transfer series.--In the transfer series the procedure of the learning series was repeated using the material of the transfer series. There were two exceptions. First, at the beginning of each trial the subjects were reminded that time was an important factor and urged to sort the cards as rapidly as possible. Second, there were six trials in this series.

The specific directions employed in both the learning and the transfer series appear in Appendix B.

Paired Associates Task

The learning series of the paired associates task involved learning to associate three pairs of nonsense syllables by means of the anticipation method. The transfer series required associating by the same method response syllables which were identical to those in the learning series to modified stimulus syllables.

Materials

The syllables in the learning series consisted of three pairs of nonsense syllables. Each syllable consisted of three letters; viz, a vowel in the medial position and consonants in the initial and final positions. These three pairs of syllables were the following:

kel pob; zab xix; bip juf

In the transfer series the stimulus member of each pair in the learning series was varied by changing the medial vowel. The response syllables in this series remained identical to those in the learning series. These three pairs of syllables may be listed as follows:

kaj pob; zub rix; bep juf

The nine different syllables employed all were selected from the group which Hilgard (22) listed as being nonsense syllables of low association value (i.e., meaningfulness).

Two Stoetling memory drums were used for the presentation of the lists of syllables. One drum was employed for each series. The speed of the machines was so calibrated that the stimulus syllable appeared alone for 2 seconds, and then the stimulus-response combination appeared together for 2 seconds. Appendix C contains pictures of the equipment employed in the administration of the two forms of the paired associates task.

Four different arrangements of the syllable pairs were contained on the two respective drums. These arrangements were developed according to the following irregular order:

Repetition of List	Sequence of Presentation Per List		
First	1	2	3
Second	2	1	3
Third	1	3	2
Fourth	3	2	1

The arrangement of the syllables in the direct learning and transfer of learning series according to this irregular order was started with different bases (i.e., initial order). The resulting arrangements of lists may be represented as follows:

Learning Series		Transfer Series	
S	R	S	R
bip	juf	zub	rix
kej	pob	bep	juf
zab	rix	kaj	pob
kej	pob	bep	juf
bip	juf	zub	rix
zab	rix	kaj	pob
bip	juf	zub	rix
zab	rix	kaj	pob
kej	pob	bep	juf
zab	rix	kaj	pob
kej	pob	bep	juf
bip	juf	zub	rix

The actual preparation of the lists for placement on the memory drums necessitated a different organization from the above. The lists as they were typed for affixing on the drums may be seen in Appendix C.

All of the nonsense syllables were typed in lower case letters with a standard typewriter in pica type on white bond paper. In addition, the three response syllables used throughout both series were typed in the same manner on 3 by 5-inch cards. Each card contained one syllable.

Procedure

Learning series.--Before the learning trials were started the subject was taught to pronounce each response syllable on sight as it appeared on the 3 by 5-inch cards. Each card was presented to the subject, and the syllable was pronounced for him. As the cards were exposed again, the subject was instructed to pronounce the syllables and mistakes were corrected. This procedure was continued until the subject could pronounce all three syllables two times without error. The cards were arranged in a different order after each reading. If at any time during the performance of the task the subject consistently mispronounced a syllable, he was given additional instruction with the cards. When the subject demonstrated that he was able to pronounce all of the response syllables, he was introduced to the learning task. This involved learning the three paired associates by the anticipation method; i.e., the first syllable appeared alone for 2 seconds, and then the stimulus and response syllables appeared together for 2 seconds; then the second stimulus syllable was presented for 2 seconds and so on through the list. One trial consisted of the presentation of one list of three paired associates. The response measure was the number of correct anticipations.

On the first trial the task was explained to the subject in detail, and he was given an opportunity to study the stimulus-response combinations. During this time the drum was stopped after each syllable or pair of syllables. The subject also was informed that although the stimulus-response pairs always remained together, the position of the pairs in the subsequent lists would be different. On the second and subsequent trials he was asked to attempt to remember some of the responses and to call them out during the 2-second anticipation periods when the stimulus syllables appeared alone.

The number of correct anticipations, the number of incorrect anticipations, and the number of omissions were recorded as the trial was in progress. This procedure was continued for 36 trials with a 30- to 45-second rest period between each trial.

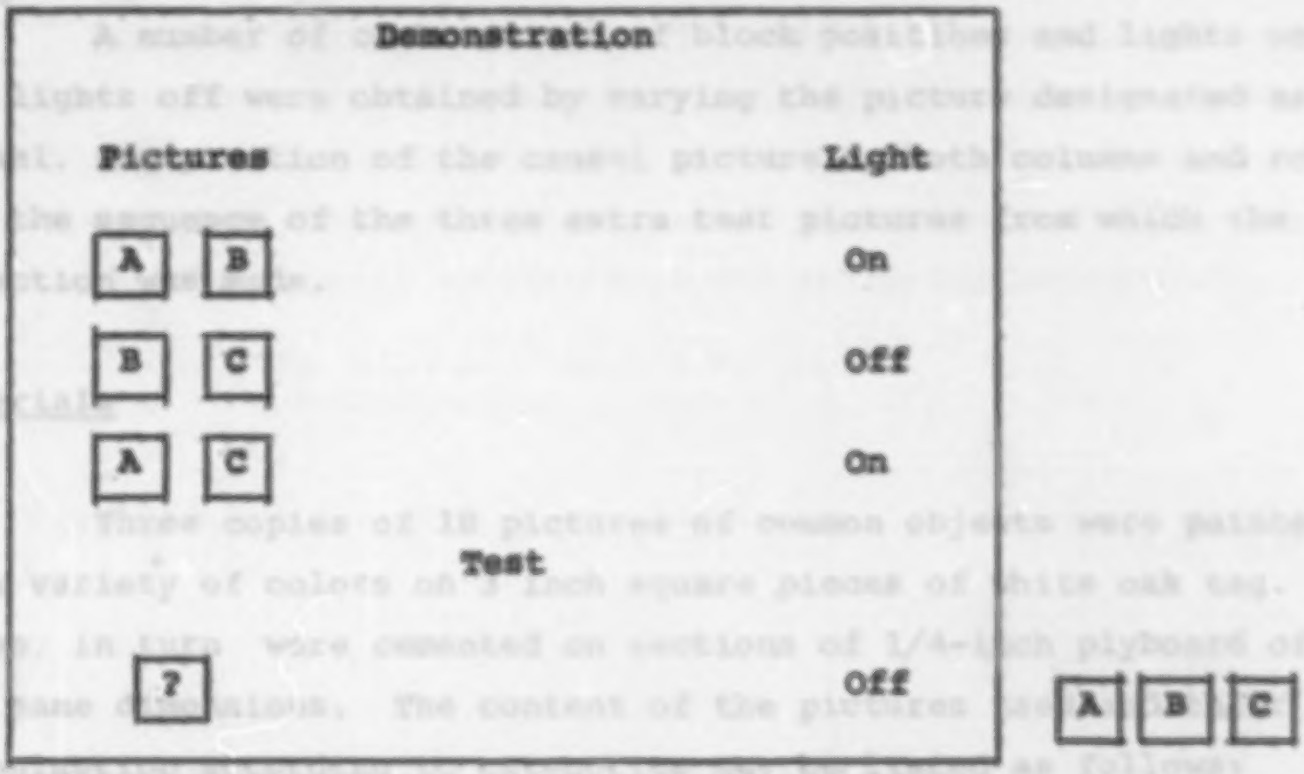
Following the learning series the subject was given a 5-minute rest period. During the rest period the memory drum containing the transfer lists was substituted for the one containing the learning lists.

Transfer series.--In the transfer series the procedure of the learning series was repeated with the material of the transfer series. The only exception was that the activity was continued for 54 trials.

The specific directions employed in both the learning and the transfer series of the paired associates task are contained in Appendix D.

Principle Task

For the principle task materials and procedures developed by Long and Welch (29) were adapted in terms of the purpose and requirements of the present investigation. In order to make a correct response in the learning series the subject had to discover a relationship between several stimuli--picture content, position of pictures, and position of lights on and off. Throughout the trials the picture content remained the same while the other stimuli were varied. Correct response in the transfer series required discovery of the same relationship (as that appropriate in the learning series) when the content of the pictures, the position of the pictures, and the position of the lights on and off were varied from trial to trial. The basic principle which was applicable to both series may be illustrated schematically by the following paradigm. A, B, and C represent pictures of objects.



Discovery of the relationship requires observation of the constellation of block positions and lights on and off in the demonstration section; when A and B are together the light is on; when B and C are together the light is not on; when A and C are together the light is on. The test involves designating which one of the three extra blocks, when placed in the empty space, will make the light go on and placement of the block. The correct solution to the problem is block A because it is located in both of the rows in which the lights are on and is not in the row in which the light is off. On the other hand, blocks B and C, although appearing one time each in the light on conditions, also are located in the row in which the light is not on. Thus, the basic principle underlying the adequate solution of all of the problems is that the causal object is always the one which is common to the two situations in which the light is on and not in the situation in which the light is off.

A number of combinations of block positions and lights on and lights off were obtained by varying the picture designated as causal, the position of the causal picture in both columns and rows, and the sequence of the three extra test pictures from which the selection was made.

Materials

Three copies of 18 pictures of common objects were painted in a variety of colors on 3 inch square pieces of white oak tag. These, in turn were cemented on sections of 1/4-inch plyboard of the same dimensions. The content of the pictures used and their organization according to categories may be listed as follows:

People	Animals	Clothes
A. boy	A. dog	A. hat
B. man	B. cat	B. coat
C. woman	C. horse	C. shoes
Furniture	**Fruit**	**Toys**
A. table	A. orange	A. ball
B. chair	B. apple	B. car
C. bed	C. banana	C. boat

In the learning series only the pictures in the people category were used. The pictures in all of the categories were employed in the transfer series.

The experimental apparatus was constructed of 1/4-inch plyboard. The face of the apparatus was painted grey; the exterior, black. The lights were controlled by switches. Pictures of the materials and the apparatus are contained in Appendix E.

Procedure

Learning series.--Only the pictures in the people category were used in this series. The three sets of pictures were shown to the subject. He was asked to name each picture. Then it was pointed out that there were three copies of each picture--boy, man, woman. The first trial consisted of the following arrangement:

Demonstration

Pictures		Lights
boy	man	On
man	woman	Off
woman	boy	On

Test

?		Off	woman	man	boy

As each pair of blocks was placed the subject was asked to name the pictures and to indicate whether the light corresponding to the particular row was on or off. In the test situation his attention was called to the single remaining space, the three remaining pictures, and the light which was off. Then he was instructed to look at the pictures in rows in which the lights were on and to look at the pictures in the row where the light was off, to decide which picture was causal, to select it from the three extras, and to place it in the empty space in order to make the (test) light go on. If the subject's first selection was incorrect, the test light was rot turned on and he was given a second choice. If the second was incorrect, he was given a third choice. The third choice was right by elimination. Whenever the correct choice was made, the test light was turned on and the answer was verbally designated as right.

Next the subject was instructed to look at the pictures in the rows in which the lights were on and at the pictures in the row in which the light was not on and to tell why he chose the picture he did nor why that was the correct choice. Although his reason was designated right or wrong on the score sheet, no comment was made to the subject regarding its adequacy. The response measures recorded were whether each choice was correct or incorrect and whether the principle was correct.

This procedure was repeated in subsequent trials varying the arrangements of the six pictures and the lights on and off in the demonstration, changing the arrangement of the three extra pictures, and varying the position and identity of the causal block. The guide sheet for the arrangements appears in Appendix E. The subject was given 15 trials. If in this time he had not made the correct selection on the first choice in five consecutive trials and correctly stated the principle, he was given a hint. The hint consisted of instructing him to point to the picture which appeared in both rows in which the lights were on but not in the row in which the light was not on. Then he was given five more trials and instructed to state the principle as described above. Following the learning series the subject was given a 5-minute rest period.

Transfer series.--The procedure in the transfer series was the same as that used in the learning series with three exceptions.

First, pictures were drawn from all six categories--people, animals, clothes, furniture, fruit, and toys. The three pictures in a single category were used in any one trial, but from trial to trial the category employed was varied. Second, the subjects in this group were not instructed to verbalize (look for) the principle. After the subject's choice was designated as correct, the pictures were removed and the next trial was set up. Third, while the principle remained the same, the combinations of block positions and lights on and off differed from those in the learning series.

The specific directions employed in both the learning and transfer series of the principle task are contained in Appendix F.

General Procedure

Consistent with the design of the investigation the experimental subjects were presented with both the direct learning and the transfer of learning forms of each task while only the transfer series were given to the control subjects. All tasks were administered individually to each subject in a separate room either at the school which he attended or at the institution in which he lived. None of the rooms was completely free from noise; however, in no case did the noise become excessive or appear to be distracting to the subject.

An irregular order of sessions was maintained. The type of subject seen and the task administered were varied both within days and between days. In any one day all three tasks were administered to both control and experimental subjects. Retarded and normal subjects were seen on alternate days. Only one type of tasks was administered to a subject in any one testing session; therefore, each subject participated in three different sessions. The length of the session for the control subjects ranged from 30 to 45 minutes. The experimental subjects were involved 45 minutes to an hour.

An effort was made to put the subject at ease during the testing sessions. Praise and encouragement were given intermittently over the series of trials. In addition, between trials there was conversation pertaining to various topics. During the interval between the direct learning and transfer series the experimental subjects were allowed to walk around and to get a drink of water. In every case adequate rapport was considered to be established and maintained. Motivation appeared to remain good and indications of fatigue or boredom were not noted.

Plan for the Analysis of the Results

As stated in Chapter I the purpose of this investigation is to employ obtained performance data in evaluating a series of research hypotheses about the direct learning and transfer of learning performance of mentally handicapped and normal subjects who have similar mental ages. In so doing it was necessary to compare the samples in terms of central tendency and variability of performance over all of the trials of the tasks and, where direct response measures were available, in terms of the trends present in the curves describing group performance on each of the individual trials. Such analyses required information about relationships between the group means and variances on the total number of trials under consideration, the relationship between the means of the groups on each trial, the slope of the lines connecting the means of the separate trials, and the equality of the several slopes as indicated by the trials by groups interaction.

The response measures used in the analyses were the time per trial for the card sorting task, the number of correct syllables per trial for the paired associates task, and the number of choices required per trial for the principle task. These response measures were totaled for each subject over all of the trials and for each group on the separate trials.

Responses to the training series of the several tasks provided a measure of the direct learning performance of the two experimental groups of subjects. A similar measure existed in the responses of the two control groups of subjects to the transfer series. There were 5 training trials in card sorting task, 36 training trials in the paired associates task, and 15 training trials in the principle task. While the transfer series of each task consisted of more trials, in order to keep the extent of practice comparable, only the data based on the corresponding number of trials to those above were considered in the direct learning comparisons. The retarded-normal comparisons were made in terms of the two subgroups; retarded experimental (RE) with normal experimental (NE) and retarded control (RC) with normal control (NC). There were two reasons for this. First, the material of the training and transfer series differed in terms of similarity. Second, in two of the tasks the instructions of the two series were varied. During the training series no set was given for speed on the card sorting task, and in the principle task a set was given to search for the underlying relationship. Conversely, during the transfer series a speed set was given in card sorting and no set was given to search for the relationship in the principle task.

A transfer index was obtained by calculating the difference between the performance on the transfer series of each control-experimental pair of subjects. The occurrence of transfer was assessed by examining these differences within the normal and retarded groups. Relative transfer was evaluated by comparing the two intelligence groups in terms of the C-E values.

In cases in which the F ratio associated with the trials by groups interaction was significant, it was inferred that the two groups of subjects being compared responded differently over the same trials. When this occurred, scrutiny of smaller sections of trials seemed indicated in order to localize these differences and to gain further information about the characteristics of the subjects' performance at the several stages of practice. Because improvement could be expected to be rather rapid in the card sorting and principle tasks, it was decided arbitrarily to examine rather small segments of the trials. In the direct learning comparisons these included the first two and the last three trials of card sorting and each third of the 15 trials of the principle task; on the transfer series each third of the trials of both tasks was considered. On the paired associates task improvement was expected to be more gradual; therefore, an evaluation was made of each half of the trials in the learning series and each third of those in the transfer series.

The statistical techniques employed in these analyses were the Type I analysis of variance design presented by Lindquist (28), and the _t_-test for correlated means and the Snedecore F-test of homogeneity of variance as described by Edwards (15). One-tailed tests were made in all comparisons in which direction was predicted. The .05 level of probability was chosen as the criterion for the rejection of the null hypotheses in all comparisons.

When the ratio obtained by means of the Snedecor F-test was associated with the .01 level of probability or less, it was concluded that the groups involved differed markedly in terms of homogeneity of variance. In determining the probability of the *t* ratio yielded by the analysis of the mean performance of the groups who showed such heterogeneity of variance, the table of *t* was entered with one-half of the usual number (fourteen) of degrees of freedom (15).

CHAPTER III

RESULTS AND DISCUSSION

Enumerated in Chapter I was a series of research hypotheses pertaining to the direct learning and transfer of learning performance of mentally handicapped and intellectually normal subjects with similar mental ages. In the present chapter an attempt will be made to evaluate these hypotheses in terms of the results of detailed analyses of the obtained performance data. These data were collected when the learning and transfer forms of three tasks were administered to 30 mentally handicapped and 30 intellectually normal boys who were matched individually on the basis of mental age. However, before the hypotheses about relative performance can be evaluated meaningfully,it would seem appropriate to determine whether or not it can be inferred that the participating subjects showed a significant amount of direct learning and transfer of learning on the tasks as employed in this investigation. In order to carry out both of these objectives the data obtained in the administration of all three tasks will be summarized within the framework of the two primary areas of interest, i.e., direct learning and transfer of learning. The treatment of each topic will include the rationale underlying the expectations about performance, a presentation of data pertaining to the demonstration that direct learning and (in the second topic) transfer of learning occurred, and a summary of the results bearing on each of the hypotheses.

Direct Learning

Rationale

For the purposes of this investigation learning was defined as a change in performance which occurs under the conditions of practice. If the trend analyses furnish evidence that the slope of the lines connecting the means of the separate trials of the tasks differ significantly from zero, then it can be inferred that a change in performance occurred under the conditions of practice. Other investigators have reported that mentally handicapped and intellectually normal subjects improve in performance during repeated trials on novel tasks which require behavior within the limits of their capabilities for change. The tasks proposed for inclusion in this investigation were administered to a number of intellectually retarded and normal children whose mental ages were approximately within the 7 to 12-year range. On the basis of the results of this pilot testing and a scrutiny of the literature pertaining to learning experiments with children the materials were selected and the procedures were developed in such a way that response to the tasks was considered to be within the limits of the capacities of the subjects participating in the study. In addition, every effort was made to employ specific materials and activities with which there was reason to believe the subjects had not had previous experience. Therefore, it was expected that from trial to trial increments or decrements would occur in the response measures of all three tasks.

The first hypothesis pertained to direct sensorimotor learning. Thompson and Magaret (30, 44), Jones (25), Taylor (43), and McFaddin (24) reported that the performance of mentally handicapped subjects was superior to that of intellectually normal subjects with similar mental ages in certain psychometric test situations. Specifically, these activities required the purposeful manual manipulation of test materials under speed and nonspeed sets and minimal verbal responses. Wilson (47) observed the same relationship in his comparisons of intellectually dull-normal and superior children. Such results are logical when it is realized that in these comparisons the retarded subjects were older chronologically than were the normal subjects. Other factors being equal, a more advanced stage of physical maturation and neuromuscular coordination generally is considered to be concomitant with higher chronological age.

The mentally handicapped individuals with whom the present investigation is concerned have chronological ages within the limits of 12 years, 11 months to 17 years; their mean chronological age is 15 years. On the other hand, the mean chronological age of the normal children is 10 years, 2 months and the range is from 7 years, 8 months to 12 years, 5 months, inclusive. On the basis of these considerations it is hypothesized that in a situation involving direct sensorimotor learning the mean performance of mentally handicapped subjects is superior to that of intellectually normal subjects with similar mental ages.

Two lines of evidence bear implications for an hypothesis concerning relative performance on rote learning tasks. First, Brownell and others (3, 4) consider that the fundamentals of reading and arithmetic represent a type of material which they call arbitrary associations. They maintain that these arbitrary associations are acquired through rote learning. The comparative data obtained by Jones (25), Merrill (32), Cruickshank (8), and Dunn (14) indicate that as a rule, retarded and normal children do not differ on these more mechanical aspects of school achievement. These data might lead to the prediction that the two classes of subjects do not differ in rote learning ability. However, a second line of evidence suggests a different expectation. The item analyses of psychometric test performance reported by McFaddin (34), Thompson and Magaret (30, 44), Taylor (43), Jones (25), and Fox (16) reveal that, in most cases, retarded subjects respond less adequately than do intellectually normal subjects with similar mental ages to subtests which involve immediate memory of lists of digits, words, syllables, and sentences. Such data indicate that the two types of subjects do differ in ability to respond to material requiring rote repetition. The key to this discrepancy appears to be in the amount of time involved. School achievement is developed over long periods of practice, while the latter type of performance necessitates response during a short time span. The interest of the present study is in rote learning which takes place in the immediate situation; i.e., the emphasis is on response during a relatively short period of time. Therefore, it is hypothesized that the mean performance of intellectually normal subjects in direct rote learning is superior to that of the mentally handicapped subjects with similar mental ages.

Traditionally, retarded subjects have been believed to be deficient in the ability to discover and employ an underlying principle on which adequate performance in a problem situation is based. Previous experimentation has tended to support this supposition. In the area of academic achievement Cruickshank (8), Dunn (14), Jones (25), and Merrill (32) all noted that mentally handicapped subjects showed less adequate responses than did intellectually normal subjects in those aspects of arithmetic and reading performance which are considered to reflect comprehension, reasoning, and problem solution. Doll (12), McFaddin (34), Thompson and Magaret (34, 44), and Wallin (46) observed the same relationships in their studies of relative psychometric test performance. It would seem, then, logical to hypothesize that intellectually normal subjects surpass mentally handicapped subjects of comparable mental ages in performance in a learning situation involving the discovery of a principle.

In the comparative investigations conducted previously the within groups variability shown by the subjects has not received as much attention as mean performance. Colvin (6), in his evaluation of results obtained in the administration of a letter cancellation task, observed that the performance of five normal subjects was more homogeneous than that of five retarded subjects. Nevertheless, he did not report a statistical analysis of the relationship. On the other hand, Woodrow (49) did perform such an analysis of data obtained in the administration of a sorting task similar to that used in the current study. The retarded subjects showed slightly more variability than did the normal subjects but the difference was not significant. Comments about the relative variability shown by the subjects in response to academic and psychometric tasks were not found in the articles reviewed. However, examination of the standard deviations reported in these studies reveal that, on the whole, mentally handicapped and intellectually normal subjects do not differ markedly in terms of homogeneity of variance in situations involving manual manipulation of test materials, rote repetition, comprehension, reasoning, and problem solving. Therefore, assuming that no extraneous factors are present which might be related to extreme inter-individual variability, there is no basis for hypothesizing heterogeneity of variance in the direct learning performance of mentally handicapped and intellectually normal subjects who are performing under similar conditions of practice.

If the statistical tests furnish evidence that the slopes of the lines connecting the trial means of the groups are not equal, then it can be inferred that there is a differential effect between groups and trials. That is to say, there is reason to believe that the subjects show a different pattern of increments or decrements over the same trials. Behaviorally, this can be described as a difference in the speed of improvement under the conditions of practice or rate of learning.

Both Murdoch (33) and Davidson (11) obtained results which indicated that over a specified period of time intellectually normal children show more improvement in the acquisition of academic skills than do retarded children with similar mental ages. In Murdoch's investigation 12 months intervened between the initial and final testing. The corresponding period in Davidson's study was 4 1/2 months. Although these investigations may be criticized on several points of methodology, it has been suggested that the observed differences are probably valid ones and that the time element is an important factor in understanding them. Since, by definition, individuals with different intelligence quotients have different rates of mental growth, it could be expected that, other things being equal, a differential increment in academic performance would occur over a relatively long time period.

On the other hand, Woodrow studied the improvement with practice shown by retarded and normal subjects during a shorter span of time. He found no difference between the performance of the subjects over thirteen daily practice periods. Woodrow's (49) investigation involved a different type of task than those employed by Murdoch and Davidson and the role of this factor is not known. However, his results do suggest (as does the theory of mental growth) that there is little reason to expect a differential rate of learning if a short enough time period is involved. In the present investigation the emphasis is on direct learning during relatively short spans of time. Therefore, it is hypothesized that the rate of increments shown by the retarded subjects in the three types of learning performance does not differ from that shown by intellectually normal subjects.

Hypotheses

H_1: The mean performance of mentally handicapped subjects in direct sensorimotor learning is significantly superior to that of intellectually normal subjects with similar mental ages.

The card sorting task was selected as an activity which primarily reflected sensorimotor learning. Successful performance appeared to require the accurate and rapid manipulation of a number of cards in terms of four pairs of identical stimuli. That is to say, the subject had to discriminate between the four different designs, to not the similarity between the cards to be sorted and the designs on the label cards attached to the boxes, and then to place the cards in correct boxes as fast as possible. The response measure was the number of seconds required per trial to sort 32 cards. Since increasing speed was reflected by decreasing scores, improvement in performance under the conditions of practice was demonstrated by progressive time decrements over the sequence of trials.

The results of the trend analyses of the mean performance of the retarded and normal subjects on each of the 5 direct learning trials of the card sorting task are summarized in Table 4. In both

TABLE 4

TREND ANALYSES OF DIRECT LEARNING PERFORMANCE ON THE CARD SORTING TASK

	Source	df	SS	MS	F
Total Trials:RE-NE	Between groups	1	709.81	709.81	6.444*
	Error (b)	28	3,089.06	110.28	
	Between trials	4	346.90	86.725	14.32***
	T x G	4	31.86	7.965	1.31
	Error (w)	112	678.42	6.058	
Total Trials:RC-NC	Between groups	1	808.29	808.29	4.64*
	Error (b)	28	4,874.73	174.03	
	Between trials	4	213.35	53.34	11.23***
	T x G	4	7.26	1.815	
	Error (w)	112	531.80	4.749	

*Significant at less than the .05 level

***Significant at less than the .001 level

the experimental and control groups comparisons the between trials F ratios were associated with probability levels which are smaller than .001. These results would seem to suggest that the slope of the lines connecting the separate trial means showed a highly significant deviation from zero. Examination of the curves (Figures 1 and 2) describing these means reveals that the deviations are manifested in terms of falling curves. Therefore, it is possible to infer that the retarded and normal subjects showed an improvement in direct learning performance under the conditions of practice on the card sorting task.

Contained in Table 5 are the data yielded by the analyses of the central tendencies apparent in the direct learning performance of the retarded and normal subjects on the card sorting task.

TABLE 5

COMPARISONS OF THE CENTRAL TENDENCIES IN DIRECT LEARNING PERFORMANCE ON THE CARD SORTING TASK

Groups	$\bar{X}$ (Retarded)	$\bar{X}$ (Normal)	$\bar{D}$	t
RE-NE	153.48	175.23	21.75	2.559*
RC-NC	138.73	161.95	23.22	2.608*

*Significant at less than the .05 level

Relatively low scores on this task represented superior performance. The over-all mean time scores of the retarded experimental and control groups were significantly lower than those of the corresponding normal groups. Thus, hypothesis 1 is supported.

These results are consistent with expectations based on a priori considerations and data reported by investigators concerned with

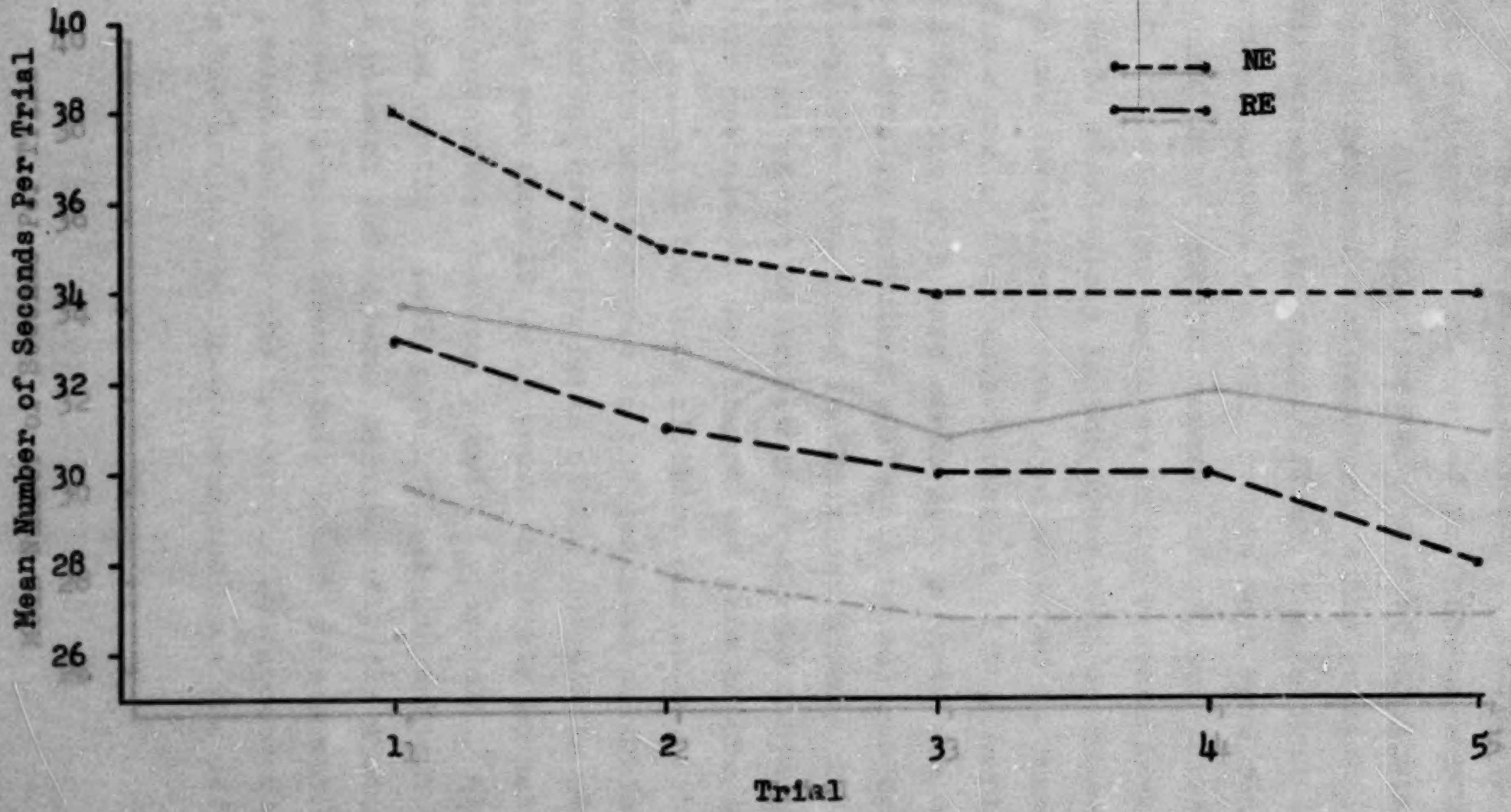


Fig. 1. Curves describing the direct learning performance of the retarded and normal experimental subjects on the card sorting task.

relative psychometric test performance. However, they are not in agreement with the results obtained by Woodrow (49). He found no significant difference between the performance of retarded and normal subjects during thirteen days of practice on a geometric form sorting task. Although there is a general similarity between Woodrow's sorting task and that employed in the present investigation, a number of differences also exist. First, the designs on the objects Woodrow's subjects were required to sort were conventional geometric figures (star, circle, square, cross, and triangle) which could be named. The designs employed in the present investigation were assumed to be meaningless in the sense that no common name or label known to the investigator could be attached to them. Second, there are differences in the characteristics of the samples. Woodrow's retarded subjects were drawn from a state residential school for the mentally deficient while his normal subjects were public school children who lived in their own homes. In addition, Woodrow reported no effort to screen the retarded subjects for possible organic pathology. An attempt was made in the present investigation to control for both of these variables. Third, Woodrows's subjects participated in the learning situation as a group. The retarded group consisted of 20 individuals who ranged in chronological age from 10 to 19 years while his normal group was composed of 16 youngsters between 9 and 10 years old. All directions were administered orally. During each trial the subject was required to sort from a pile of 250 objects continuously for 4 minutes. There were two such trials immediately following one another during one practice period and only the results of the second trial were tabulated. In his article Woodrow commented upon the difficulty

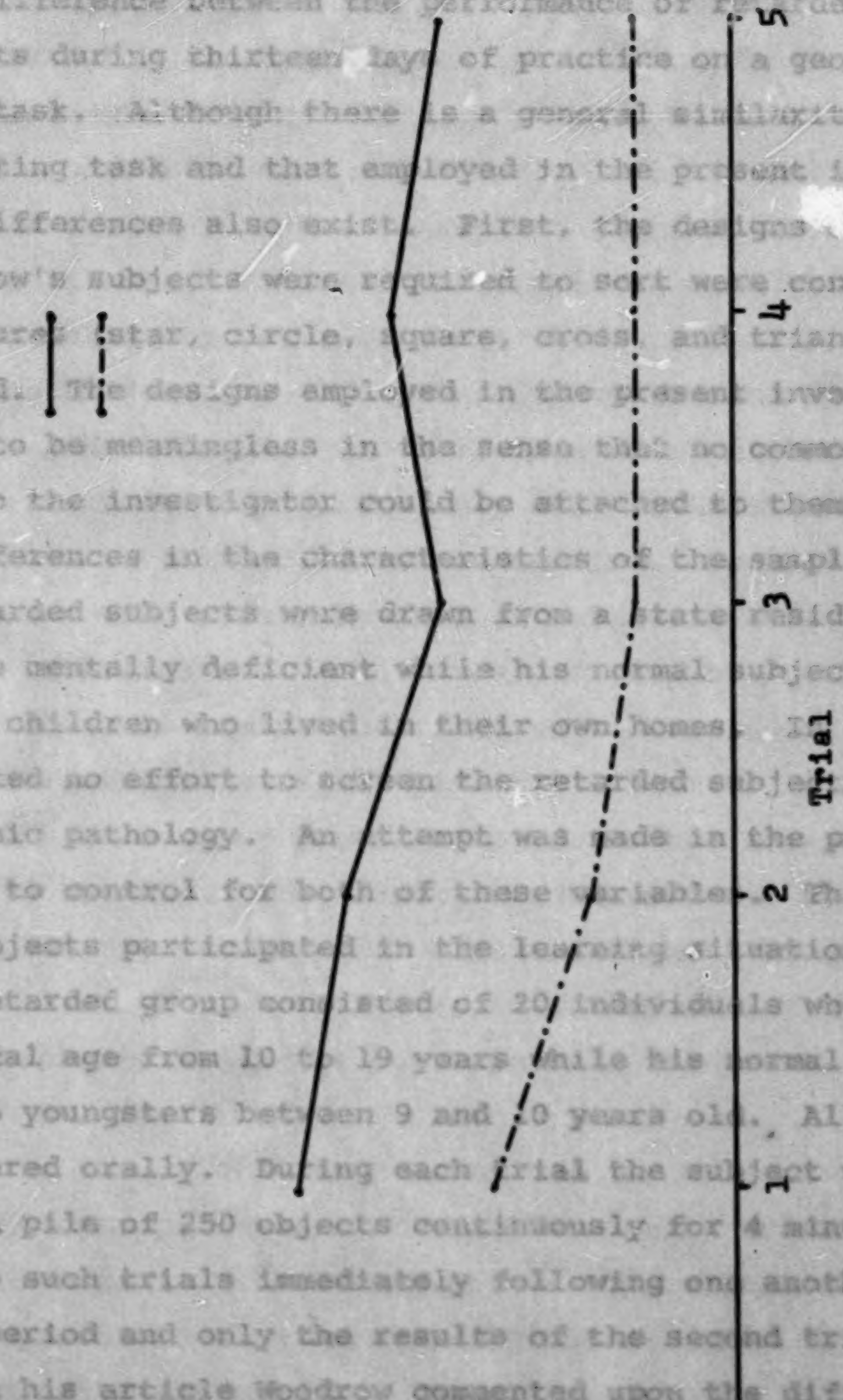


Fig. 2. Curves describing the direct learning performance of the retarded and normal control subjects on the card sorting task.

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> H_2: The mean performance of intellectually normal subjects in direct rote learning is significantly superior to that of mentally handicapped subjects with similar mental ages.

Performance on the paired associates task was assumed to be dependent primarily upon rote learning ability. The subjects were required to learn by repetition the arbitrary association between a series of relatively meaningless nonsense syllables. The number of nonsense syllables correctly associated per trial was the response measure in terms of which performance was assessed. Improvement in performance under the conditions of practice was reflected by progressive increments in scores over the series of trials.

Table 6 consists of the results of the trend analyses of the

TABLE 6

TREND ANALYSES OF DIRECT LEARNING PERFORMANCE ON THE PAIRED ASSOCIATES TASK

	Source	df	SS	MS	F
Total Trials:RE-NE	Between groups	1	56.95	56.95	5.53*
	Error (b)	28	288.40	10.30	
	Between trials	35	402.98	11.53	20.85***
	T x G	35	16.55	.473	
	Error (w)	980	541.53	.553	
Total Trials:RC-NC	Between groups	1	15.89	15.89	2.71
	Error (b)	28	164.24	5.86	
	Between trials	35	453.58	12.97	22.96***
	T x G	35	19.75	.565	1.14
	Error (w)	980	487.09	.497	

*Significant at less than the .05 level

***Significant at less than the .001 level

direct learning performance of the retarded and normal subjects over 36 trials of the paired associates task. The probabilities of the between trials F ratios were less than .001 in both comparisons. These data would seem to indicate that the slope of the lines connecting the trial means showed a highly significant deviation from zero. The curves representing the trial-by-trial performance of the subjects appear in Figures 3 and 4. Scrutiny of these performance curves reveals that the deviations in slope take the form of rising curves. Thus, the inference seems warranted that the retarded and normal subjects improved in direct learning performance under the conditions of practice on the paired associates task.

Included in Table 7 is the information pertinent to the comparisons of the retarded and normal groups in terms of central tendency of direct learning performance on the paired associates task. Superior performance on this task was manifested by relatively high scores. Inspection of the data contained in Table 7 reveals that the hypothesis that the mean performance of the normal subjects excels that of retarded subjects is only partially supported. The mean number of syllables correctly associated by the normal

TABLE 7

COMPARISONS OF THE CENTRAL TENDENCIES IN DIRECT LEARNING PERFORMANCE ON THE PAIRED ASSOCIATES TASK

Groups	$\bar{X}$ (Retarded)	$\bar{X}$ (Normal)	$\bar{D}$	t
RE-NE	55.07	71.60	16.53	2.147*
RC-NC	62.00	70.73	8.73	1.670

*Significant at less than the .05 level

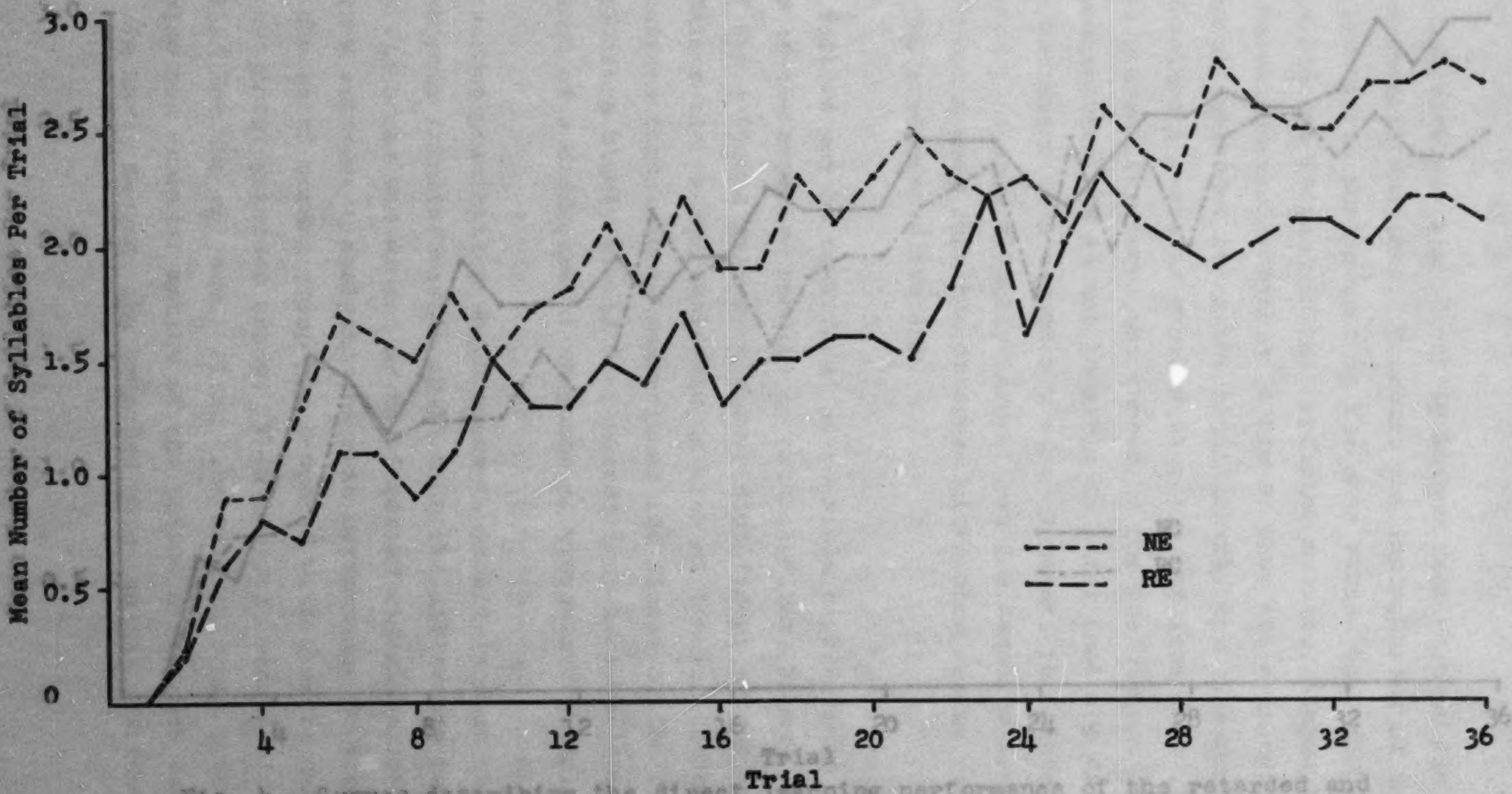

Fig. 3. Curves describing the direct learning performance of the retarded and normal experimental subjects on the paired associates task.

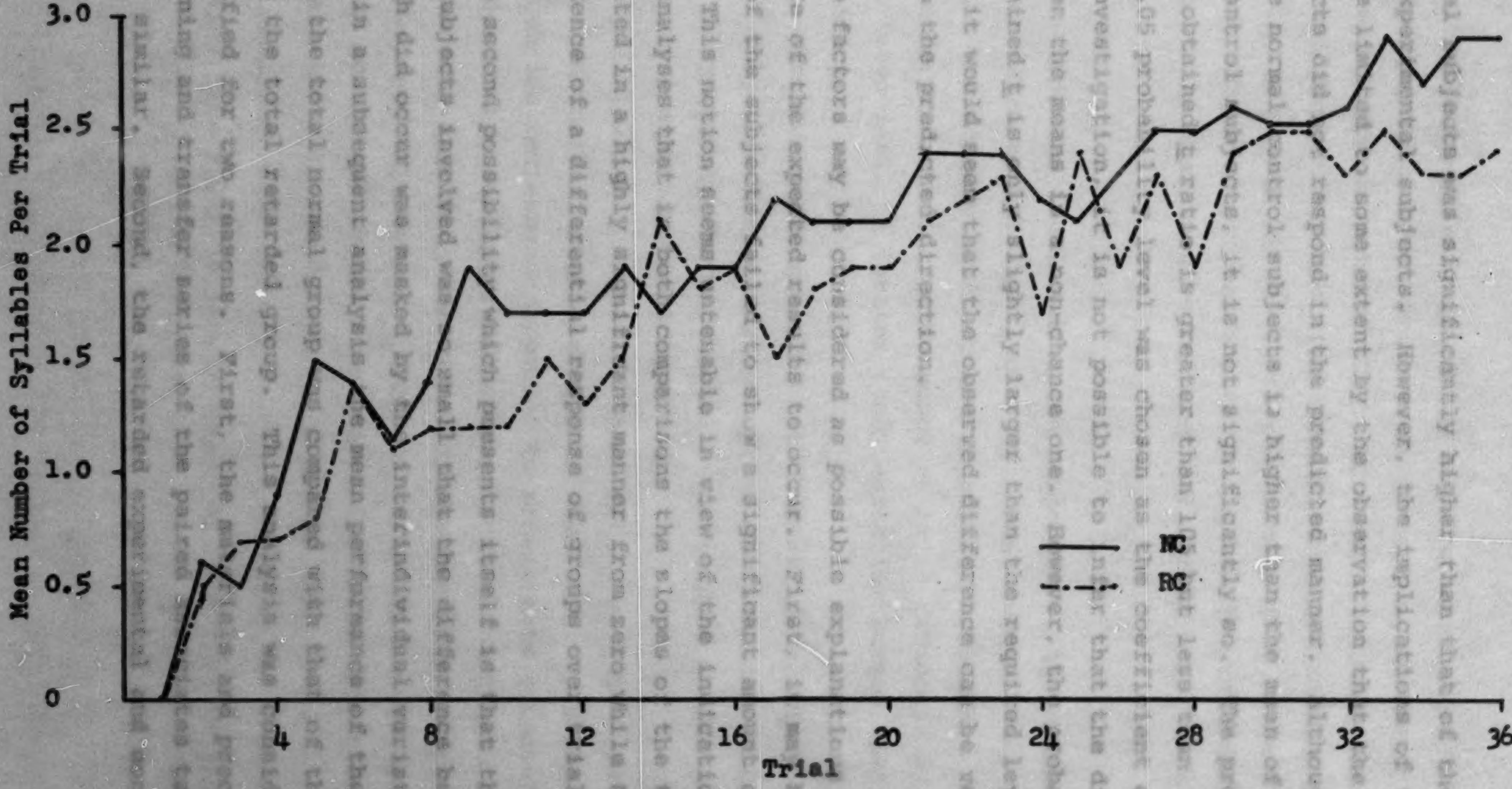

Fig. 4. Curves describing the direct learning performance of the retarded and normal control subjects on the paired associates task.

experimental subjects was significantly higher than that of the retarded experimental subjects. However, the implications of these results are limited to some extent by the observation that the control subjects did not respond in the predicted manner. Although the mean of the normal control subjects is higher than the mean of the retarded control subjects, it is not significantly so. The probability of the obtained t ratio is greater than 105 but less than .10. Since the .05 probability level was chosen as the coefficient of risk for this investigation, it is not possible to infer that the difference between the means is a non-chance one. However, the probability of the obtained t is only slightly larger than the required level; therefore, it would seem that the observed difference can be regarded as being in the predicted direction.

Two factors may be considered as possible explanations of this failure of the expected results to occur. First, it may be that some of the subjects failed to show a significant amount of learning. This notion seems untenable in view of the indication of the trend analyses that in both comparisons the slopes of the trial means deviated in a highly significant manner from zero while there was no evidence of a differential response of groups over trials.

The second possibility which presents itself is that the number of subjects involved was so small that the difference between groups which did occur was masked by the interindividual variation. Therefore, in a subsequent analysis the mean performance of the 30 subjects in the total normal group was compared with that of the 30 subjects in the total retarded group. This analysis was considered to be justified for two reasons. First, the materials and procedures of the learning and transfer series of the paired associates task were highly similar. Second, the retarded experimental and control groups were homogeneous in terms of the means and variances of their direct learning performance. So were the normal experimental and control groups.[1] The results of this additional analysis indicated that the total groups differed significantly in terms of mean performance. The normal group had the higher mean. This outcome is considered to suggest that consistently significant t ratios might be obtained if the task were replicated with larger numbers of subjects.

Thus, while no final conclusion is possible, the evidence does seem to indicate that intellectually normal subjects are probably superior to mentally handicapped subjects of comparable mental ages in direct rote learning performance as it is reflected by the paired associates task. A further study employing larger samples is suggested.

> H_3: The mean performance of intellectually normal subjects in discovering a principle is significantly superior to that of mentally handicapped subjects with similar mental ages.

The principle task was selected as one involving an activity which has been described as comprehension, reasoning, or problem solving. Accurate performance appeared to necessitate purposeful response based on the determination and application of the relationship among several stimuli. The number of choices required per trial was the response measure in terms of which performance on this task was evaluated. Decreasing scores indicated improvement in performance under the conditions of practice.

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[1] RE-RC: $t = 1.022$, P greater than .05; $F = 2.23$, P greater than .05. NE-NC: $t = .164$, P greater than .05; $F = 1.03$, P greater than .05.

The results of the trend analyses of the trial-by-trial direct learning performance of the subjects on the principle task are listed in Table 8. The between trials F ratios were associated with probabilities which are less than .01 in both comparisons. There is reason to believe on the basis of these data that the slope of the lines connecting the trial means showed a highly significant deviation from zero. Examination of the pictorial evidence in Figures 5 and 6 reveals that these deviations in slope are manifested in terms of falling curves. For these reasons it can be inferred that the retarded and normal subjects improved in direct learning performance under the conditions of practice on the principle task.

TABLE 8

TREND ANALYSES OF DIRECT LEARNING PERFORMANCE ON THE PRINCIPLE TASK

Source		df	SS	MS	F
Total Trials:RE-NE	Between groups	1	.72	.72	
	Error (b)	28	23.24	.830	
	Between trials	14	9.69	.692	3.01**
	T x G	14	2.48	.177	
	Error (w)	392	90.23	.230	
Total Trials:RC-NC	Between groups	1	.02	.02	
	Error (b)	28	76.98	2.748	
	Between trials	14	10.70	.764	2.68**
	T x G	14	3.88	.277	
	Error (w)	392	111.95	.285	

**Significant at less than the .01 level

Table 9 contains the data pertinent to the evaluation of the central tendencies observable in the subjects' direct learning

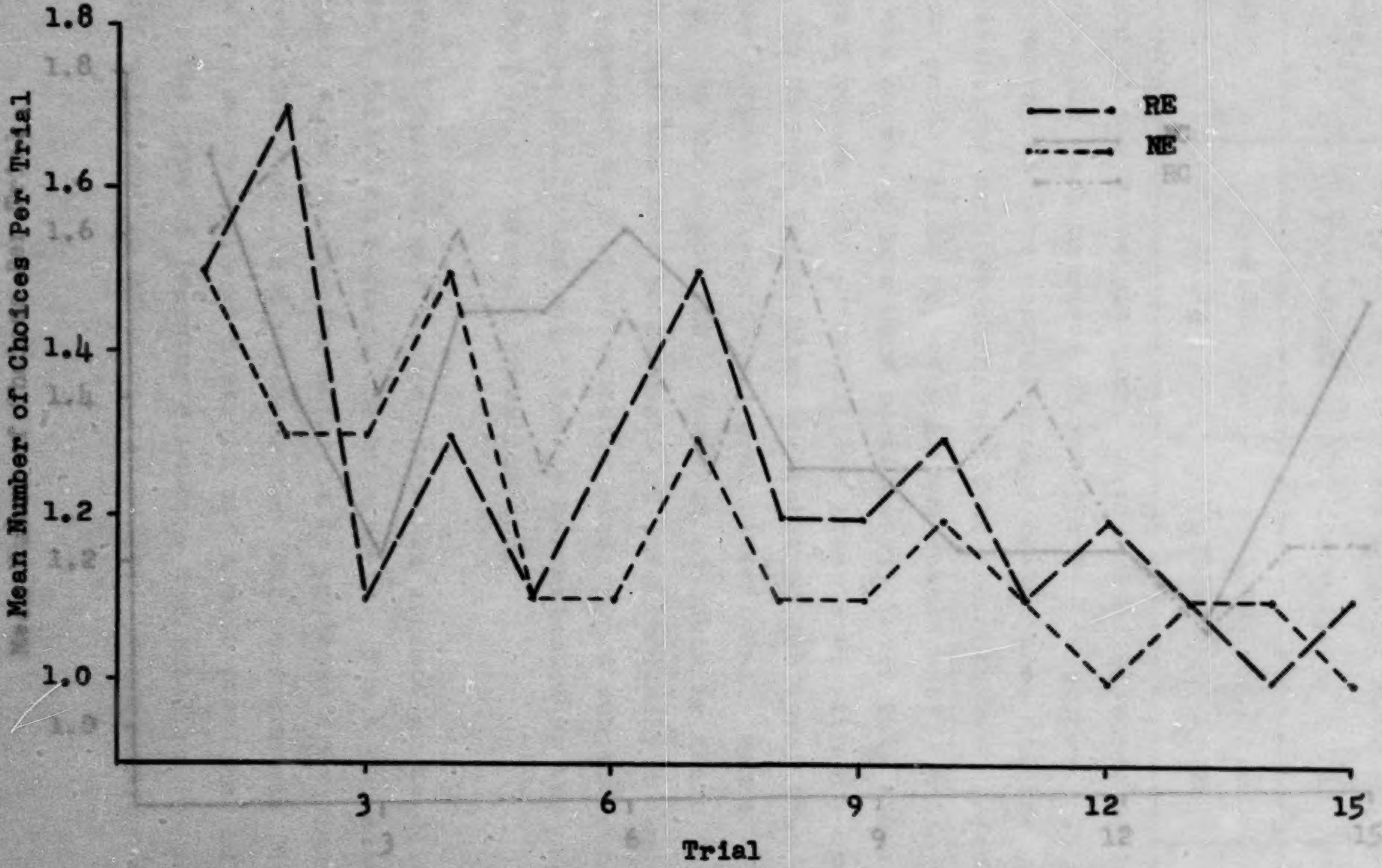

Fig. 5. Curves describing the direct learning performance of the retarded and normal experimental subjects on the principle task.

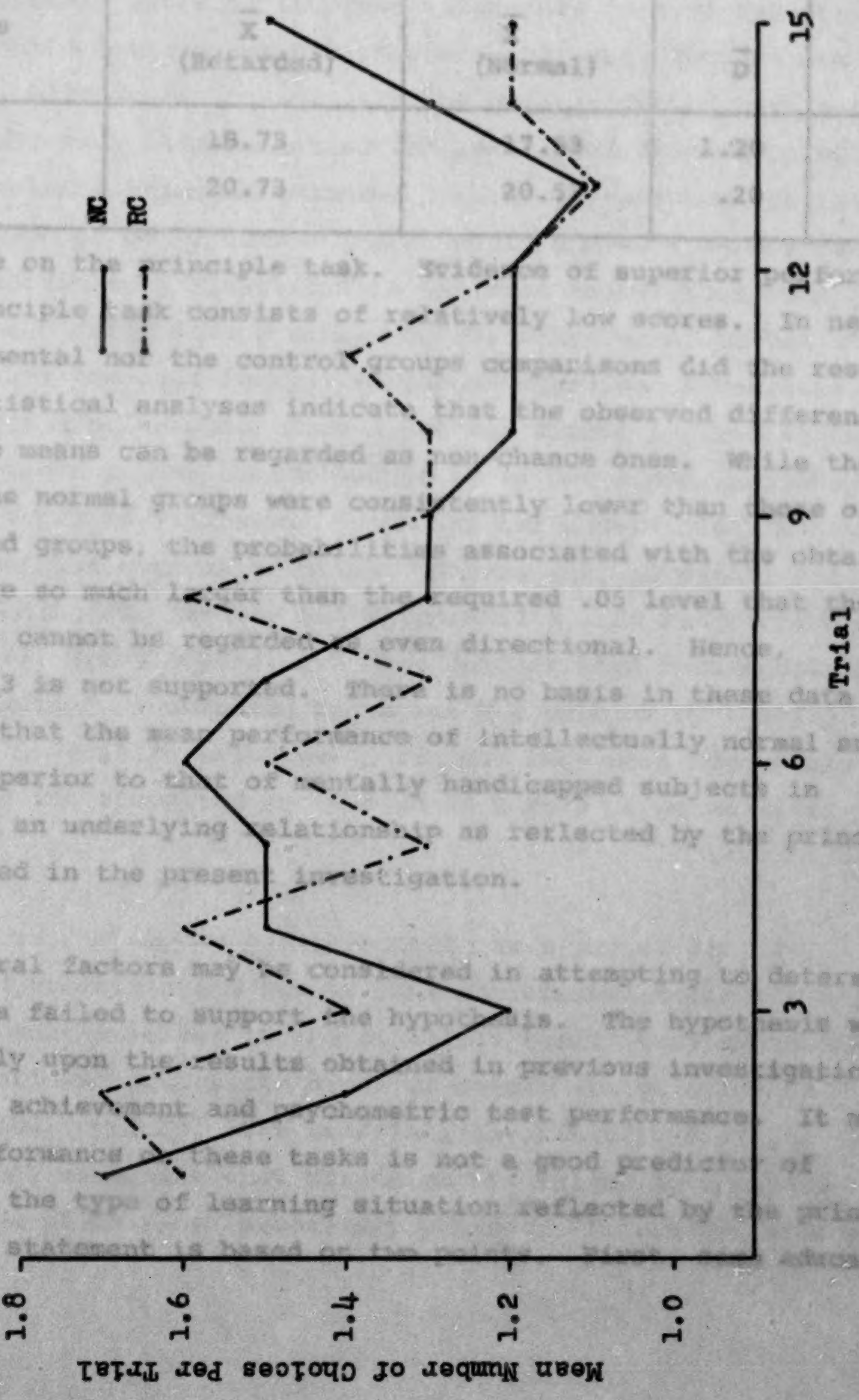

Fig. 6. Curves describing the direct learning performance of the retarded and normal control subjects on the principle task.

TABLE 9

COMPARISONS OF THE CENTRAL TENDENCIES IN DIRECT LEARNING PERFORMANCE ON THE PRINCIPLE TASK

Groups	X̄ (Retarded)	X̄ (Normal)	D̄	t
RE-NE	18.73	17.53	1.20	[illegible]
RC-NC	20.73	20.5[illegible]	.20	[illegible]

performance on the principle task. Evidence of superior performance on the principle task consists of relatively low scores. In neither the experimental nor the control groups comparisons did the results of the statistical analyses indicate that the observed differences between the means can be regarded as non-chance ones. While the means of the normal groups were consistently lower than those of the retarded groups, the probabilities associated with the obtained t ratios are so much larger than the required .05 level that the differences cannot be regarded as even directional. Hence, hypothesis 3 is not supported. There is no basis in these data for concluding that the mean performance of intellectually normal subjects is superior to that of mentally handicapped subjects in discovering an underlying relationship as reflected by the principle task employed in the present investigation.

Several factors may be considered in attempting to determine why the data failed to support the hypothesis. The hypothesis was based largely upon the results obtained in previous investigations of relative achievement and psychometric test performance. It may be that performance on these tasks is not a good predictor of response to the type of learning situation reflected by the principle task. This statement is based on two points. First, some educators

TABLE 9

COMPARISONS OF THE CENTRAL TENDENCIES IN DIRECT LEARNING PERFORMANCE ON THE PRINCIPLE TASK

Groups	$\bar{X}$ (Retarded)	$\bar{X}$ (Normal)	$\bar{D}$	*t*
RE-NE	18.73	17.53	1.20	.87
RC-NC	20.73	20.53	.20	.077

performance on the principle task. Evidence of superior performance on the principle task consists of relatively low scores. In neither the experimental nor the control groups comparisons did the results of the statistical analyses indicate that the observed differences between the means can be regarded as non-chance ones. While the means of the normal groups were consistently lower than those of the retarded groups, the probabilities associated with the obtained *t* ratios are so much larger than the required .05 level that the differences cannot be regarded as even directional. Hence, hypothesis 3 is not supported. There is no basis in these data for concluding that the mean performance of intellectually normal subjects is superior to that of mentally handicapped subjects in discovering an underlying relationship as reflected by the principle task employed in the present investigation.

Several factors may be considered in attempting to determine why the data failed to support the hypothesis. The hypothesis was based largely upon the results obtained in previous investigations of relative achievement and psychometric test performance. It may be that performance on these tasks is not a good predictor of response to the type of learning situation reflected by the principle task. This statement is based on two points. First, some educators contend that much too often school children are not taught to look for or to employ the generalizations involved in problem solution. Instead, academic material is often approached in a mechanistic fashion. While some youngsters independently work out and use principles, many others do not. It has been suggested that retarded subjects take such independent action less often than do intellectually normal and superior children. It would seem logical that with this type of background children would approach achievement and psychometric test situations in the same manner that they approach their daily school work. On the other hand, in the principle task the experimental subjects were given a definite set to search for a principle. Such a set was almost implied in the directions given to the control subjects in the sense that they were told to try to figure out which was the causal block and to employ it for the correct solution. Katona (26), Brownell and Mosher (2), Hilgard, Irvine, and Whipple (21), and Hendrickson and Schroder (20), among others, all have demonstrated that subjects who were taught or instructed to approach a problem by looking for or using an underlying principle performed much more adequately than did subjects who attempted to respond in a rote or mechanistic fashion.

Second, it may be possible that the types of activity tapped by psychometric and educational achievement tests are different from that involved in the principle task. Very often the former situations require the overt or covert manipulation of abstract verbal symbols. The materials and directions of the principle task were such that attention was called to concrete relationships which were immediately present. It was not necessary to manipulate verbal symbols to any great extent. Roberts (39) and Wilson (47) both observed that intellectually dull-normal and superior children with similar mental ages did not differ in performance in problem situations requiring the manipulation of concrete materials on the basis of an underlying principle. In addition, Bolles (1) reported that retarded individuals were able to deal more adequately with concrete relationships than with abstract ones.

Another possibility which must be considered is that the task was too easy for the subjects. So easy, in fact, that it did not discriminate as efficiently as a more difficult task might. If this were the case, then it would seem that significant decrements in performance would not have occurred over the series of trials. The between trials F ratios in both comparisons were associated with the .01 probability level. However, examination of the raw data reveals that 23 subjects made the correct response during the first few trials and thus reached the ceiling of the task, while 15 of the 60 subjects never did determine the principle. These subjects were distributed fairly evenly in the retarded and normal groups.

All of these factors probably contributed to the relationships observed in the results. There is a need for further comparative investigations before any final generalizations can be made. Such studies should employ more difficult tasks, tasks which involve both verbal and concrete responses, and experimental situations in which various kinds of sets are established.

> H_4: The variability of mentally handicapped subjects in the three types of direct learning performance does not differ from that of intellectually normal subjects with similar mental ages.

Summarized in Table 10 is information about the within groups variation in direct learning performance on the card sorting, paired associates, and principle tasks. According to the above listed data in all comparisons except one the retarded subjects showed more variability in direct learning performance than did the normal subjects. The one exception was in the control groups comparison on the card sorting task; here the normal subjects showed more within group variation. However, in neither the experimental nor the control groups comparisons on the card sorting, paired

TABLE 10

COMPARISONS OF THE WITHIN GROUPS VARIABILITY IN DIRECT LEARNING PERFORMANCE ON THE CARD SORTING, PAIRED ASSOCIATES, AND PRINCIPLE TASK

	Task-Groups	S^2 (Retarded)	S^2 (Normal)	F
Card Sorting	RE-NE	678.97	283.08	2.40
	RC-NC	721.34	901.94	1.25
Paired Associates	RE-NE	446.41	200.53	2.23
	RC-NC	199.80	194.00	1.03
Principle Task	RE-NE	13.91	9.31	1.49
	RC-NC	42.02	34.88	1.20

associates, or principle tasks was the ratio between the variances significant.

It has been established that learning did occur on all three tasks. Thus, hypothesis 4 is supported. It would seem justifiable to conclude that mentally handicapped and normal subjects of comparable mental ages do not differ in terms of variability in the three types of direct learning performance as reflected by the tasks employed in this investigation.

H_5: The rate of learning of mentally handicapped subjects in the three types of direct learning performance does not differ from that of intellectually normal subjects with similar mental ages.

Data included in the trend analyses presented in Tables 4, 6, and 8 are pertinent to this hypothesis.[1] Reference to these tables reveals that in no case were the F ratios associated with the trials by groups interactions significant at the .05 level of probability. As a result there was no evidence in either the experimental or control groups comparisons of performance on each of the three tasks that the slopes of the lines connecting the trial means were unequal. The subjects did show a significant amount of learning on these tasks. Therefore, hypothesis 5 is supported. It appears safe to conclude that mentally handicapped and intellectually normal subjects of comparable mental ages do not differ significantly in rate of increments or decrements in the three types of learning performance as reflected by the tasks employed in this investigation.

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[1] _Supra_, pp. 54, 60, and 66 respectively.

Transfer of Learning

Rationale

For the purposes of the present investigation transfer of learning was defined as a facilitation of performance which occurs following training on a similar task. An index of transfer was obtained by subtracting the total score obtained on the transfer task by an experimental subject who had previous training on a similar task from that of an individually matched control subject who did not have this previous training. If it can be demonstrated that the mean of the C-E values thus derived differs significantly from zero, then it can be inferred that transfer of learning occurred.

In the past a great deal of experimental work has been performed in order to determine the conditions which are most conducive to obtaining the maximum amount of transfer of learning possible. Primary among these conditions are a high degree of similarity between the elements of the training and transfer tasks and a minimum of interpolated interfering activity between the administrations of the two tasks. Every effort was made to select the materials and procedures of the tasks employed in this investigation in such a way that these conditions would exist as much as possible. Therefore, it was expected that the participating subjects would show a significant amount of transfer of learning.

McGeoch and Irion described transfer of learning in the following terms:

> Transfer of training occurs whenever the existence of a previously established habit has an influence upon the acquisition, performance, or relearning of a second habit.

> It is one of the most general phenomena of learning and, by means of its influence, almost all learned behavior is interrelated in various complex ways. Transfer serves to determine, in part, the ease of learning of a particular habit, and, indeed, every new learning takes place in the context of all previously established habits (35, p. 299).

Because of the interdependence of direct learning and the transfer of that learning it might be expected that the relationships between the transfer performance of mentally handicapped and intellectually normal children of comparable mental ages would be similar to the relationships they are expected to show in direct learning performance. However, this is not necessarily the case. Several considerations must be weighed in proposing hypotheses about relative transfer performance. First, Underwood (45) demonstrated that the degree of transfer obtained on a second task is, in part, a function of the degree of learning on the initial task. It would seem to follow that differences in transfer would occur and that the size and direction of these differences would be a function of the type of task involved. On the other hand, it must be recognized that the C-E transfer index employed in the assessment of transfer of learning furnishes a control for initial ability. With this measure only relative amounts of transfer are assessed. Second, as Cronbach (7) pointed out, one of the conditions believed to facilitate transfer is the recognition by the individual of the applicability of the initial learning to the transfer task. Retarded subjects possibly are not as adept at this recognition as normal subjects. However, there is no previous information on this point. The type of transfer situation with which the present investigation is concerned is one in which the training task is followed immediately by a transfer task which is highly similar in terms of both materials and procedure. In addition, the environmental setting remains the same. Therefore, it would seem likely that the influence of failure to recognize the appropriateness of the trained response to the criterion situation would be at a minimum. Third, it is possible that a differential rate of forgetting might have an influential effect in relative transfer performance. Whether retarded individuals forget faster than normal children with similar mental ages is a matter of conjecture. At the present time there appears to be no published data pertinent to this point. However, the emphasis in the present study is on a transfer situation in which the time interim between the administration of the training and transfer tasks is so brief that it is highly improbably that such a factor operates to any great extent.

In addition to these _a priori_ considerations there are some previous experimental data on the relative transfer performance of individuals who have different levels of intelligence but similar mental ages. Woodrow (49) and Colvin (6) observed that mentally handicapped and intellectually normal subjects did not differ in transfer performance on cancellation and sorting tasks. Roberts (39), who compared the performance of very young intellectually dull-normal and superior subjects on a task involving transfer of a principle, reported similar results.

Therefore, when all of these factors are taken into account, there seems to be no basis for hypothesizing that mentally handicapped and intellectually normal individuals of similar mental ages differ significantly in terms of any aspect of performance in situations involving the transfer of sensorimotor learning and of rote learning and the application of a previously discovered principle.

Hypotheses

H_6: The mean performance of mentally handicapped subjects in the transfer of sensorimotor learning does not differ significantly from that of intellectually normal subjects with similar mental ages.

The results of the trend analyses of the mean performance of the control and experimental subjects on each of the 6 trials of the transfer series of the card sorting task are contained in Table 11. The between trials F ratio in the retarded groups comparison

TABLE 11

TREND ANALYSES OF PERFORMANCE ON THE TRANSFER SERIES OF THE CARD SORTING TASK

	Source	df	SS	MS	F
Total Trials:RC-RE	Between	1	24.50	24.50	
	Error (b)	28	5,527.09	197.32	
	Between trials	5	175.31	35.062	9.31***
	T x G	5	49.39	9.878	2.62*
	Error (w)	140	527.67	3.768	
Total Trials:NC-NE	Between groups	1	1.80	1.80	
	Error (b)	28	4,574.18	163.30	
	Between trials	5	90.85	18.170	3.08*
	T x G	5	42.08	8.416	1.43
	Error(w)	140	826.30	5.900	

*Significant at less than the .05 level

***Significant at less than the .001 level

is significant at the .001 level of probability. The corresponding value in the normal groups comparison is significant at the .05 level. Therefore, it appears that the slope of the lines connecting the separate trial means of the groups showed a significant deviation from zero. The curves illustrating the mean performance of the subjects over the total trials appear in Figures 7 and 8. According to these representations the deviations in slope were reflected in falling curves.

Listed in Table 12 are the results of the evaluations of the central tendencies and within groups variability evident in the performance of the experimental and control subjects on the transfer series of the card sorting task. It is evident from these data that in neither the retarded nor the normal comparison did the mean C-E measure differ significantly from zero. This lack of significance was apparent both over the total six trials and at each section of trials considered. In all cases the differences in the performance of the retarded subgroups of subjects were in the expected direction. That is to say, on the average the retarded experimental subjects had lower scores than did their control group counterparts. This was not so in the normal subgroup comparisons. Over the total trials the normal experimental subjects averaged lower scores and this relationship was evident in the first section of trials. However, in the final two sections, the sign of the mean difference was in favor of the normal control subjects. With the exception of the NC-NE comparison of performance during the first section of trials the variances were homogeneous.

Thus, it can be inferred that the subjects exhibited sensorimotor learning on the transfer series of the card sorting task.

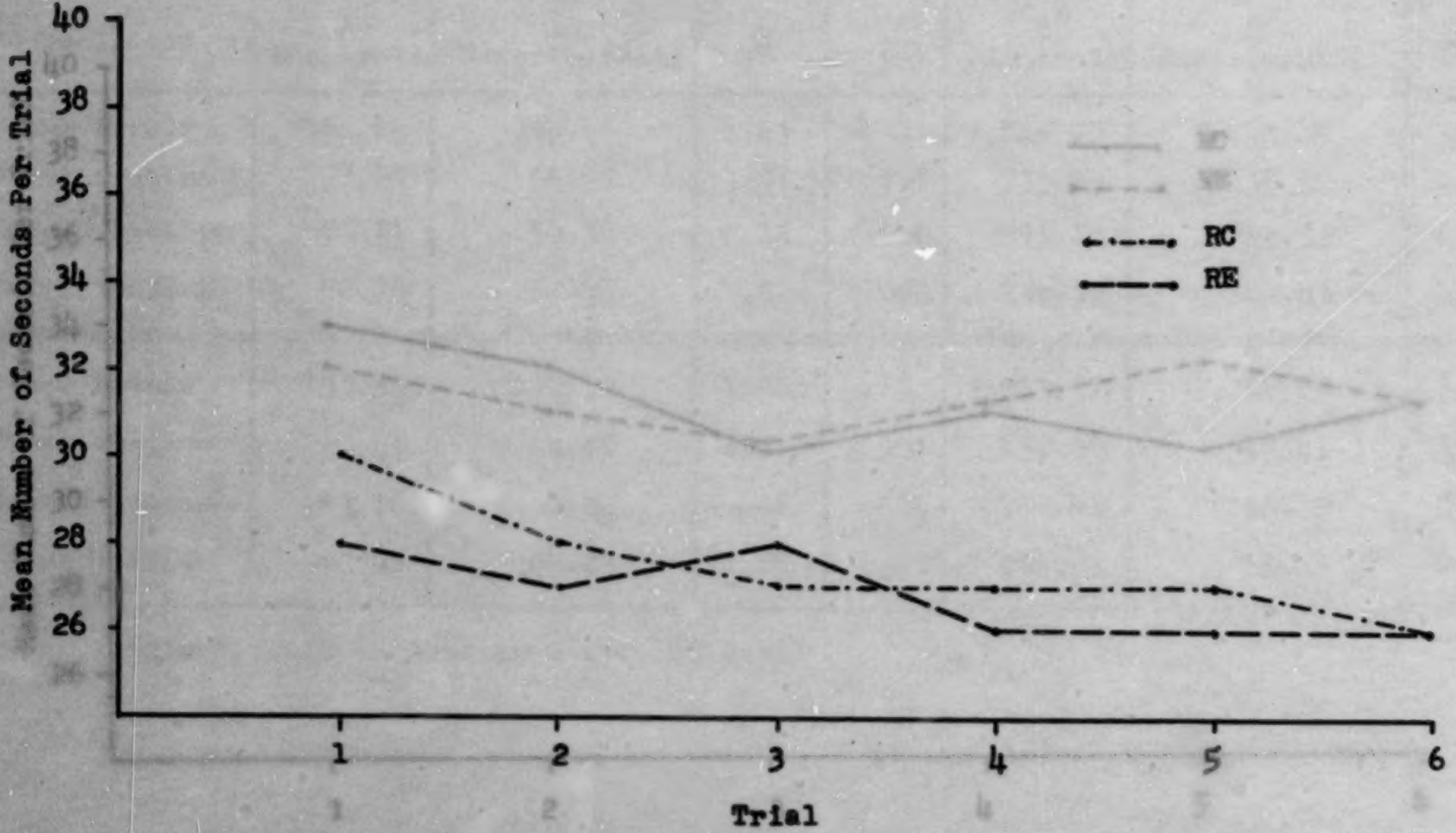


Fig. 7. Curves describing the performance of the retarded experimental and control subjects on the transfer series of the card sorting task.

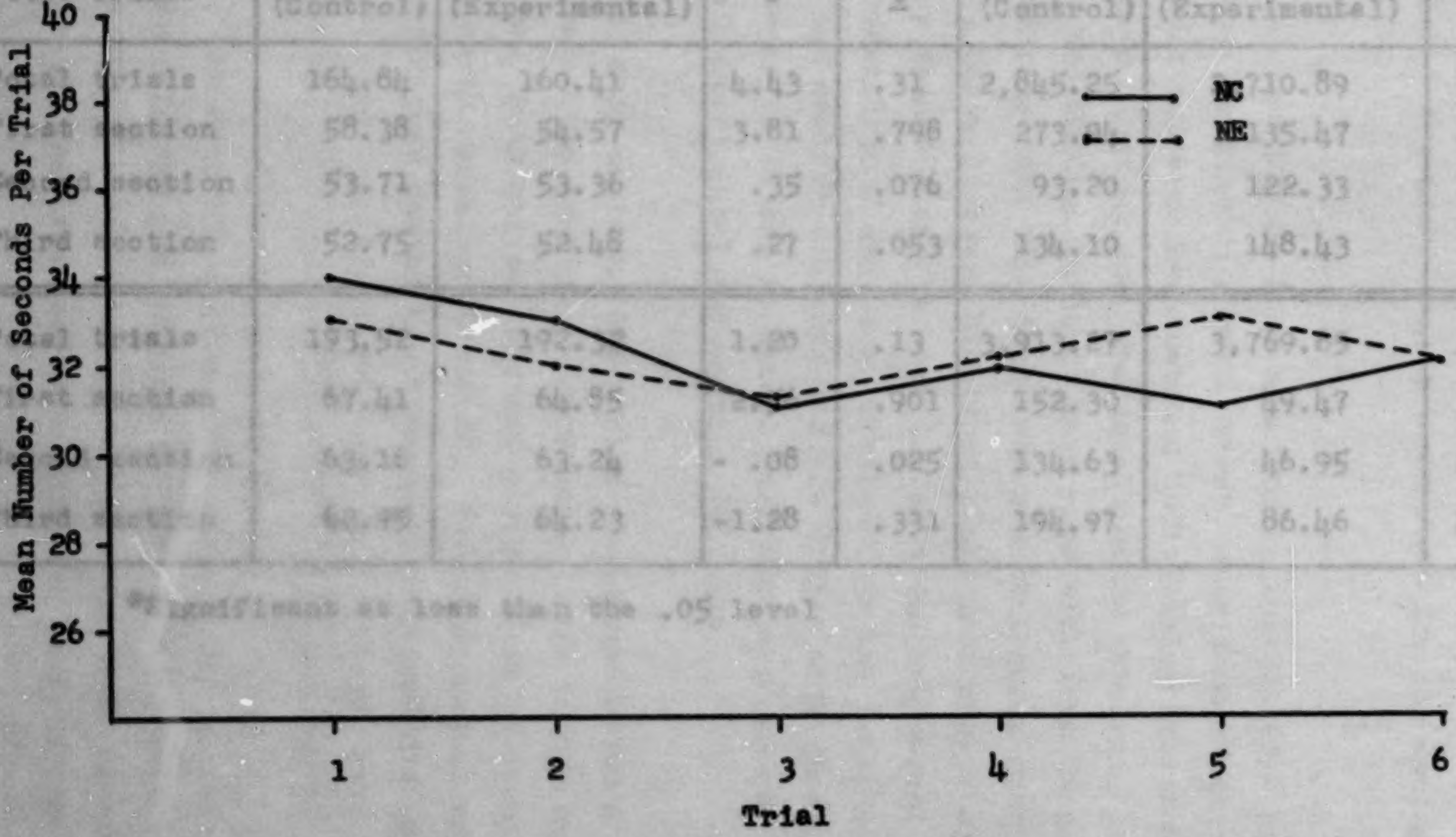


Fig. 8. Curves describing the performance of the normal experimental and control subjects on the transfer series of the card sorting task.

TABLE 12

COMPARISONS OF THE CENTRAL TENDENCIES AND OF THE WITHIN GROUPS VARIABILITY IN PERFORMANCE ON THE TRANSFER SERIES OF THE CARD SORTING TASK

Groups-Trials		$\overline{X}$ (Control)	$\overline{X}$ (Experimental)	$\overline{D}$	t	s^2 (Control)	s^2 (Experimental)	F
RC-RE	Total trials	164.84	160.41	4.43	.31	2,845.25	2,710.89	1.05
	First section	58.38	54.57	3.81	.798	273.94	135.47	2.02
	Second section	53.71	53.36	.35	.076	93.20	122.33	1.31
	Third section	52.75	52.48	.27	.053	134.10	148.43	1.11
NC-NE	Total trials	193.52	192.32	1.20	.13	3,913.27	3,769.65	1.04
	First section	67.41	64.85	2.56	.901	152.30	49.47	3.07*
	Second section	63.16	63.24	- .08	.025	134.63	46.95	2.86
	Third section	62.95	64.23	-1.28	.331	194.97	86.46	2.25

*Significant at less than the .05 level

However, although some trends are apparent, there is no basis for believing that either the mentally handicapped or the normal subjects showed a significant amount of transfer of learning on this task. For this reason there are not sufficient data for the evaluation of hypothesis 6.

Several factors may have operated in this failure of transfer of sensorimotor learning to occur. First, even though the control and experimental subjects were matched individually in terms of mental age, chronological age, and intelligence quotient, it is possible that the control subjects were more efficient in performance on the card sorting task than their experimental group counterparts. On an _a priori_ basis it seems highly unlikely that such a situation would occur by chance alone in both the retarded and normal groups. In addition, statistical analyses revealed that the retarded experimental and control subjects did not differ significantly in terms of means or variances in direct learning performance. Neither did the normal experimental and control subjects.

Second, only a short time period intervened between the administrations of the practice and transfer tasks to the experimental subjects. Both series required a great deal of sustained attention and rapid manual performance. The experimental subjects possibly were fatigued during the transfer trials and did not respond as adequately as they might have, had a longer rest period been involved.

Third, the directions given in the two tasks varied slightly. Not as much emphasis was put on speed in the training task as in the transfer task. The experimental subjects may have developed a mode of response in the training task which was carried over to such an extent that they did not respond to the verbal reminders that speed was important.

These considerations would seem to indicate that failure of transfer to occur cannot be attributed to a selective factor in the sample. Rather, it is probable that some aspects of the previous training period administered to the experimental subjects exerted a detrimental effect in the transfer situation. The control subjects, not having had this prior experience, did not succumb to these negative influences. Thus, it is likely that the transfer of sensorimotor learning which should have occurred was masked by the results of procedural errors. Further research in which these factors are taken into consideration will have to be conducted before any final generalization can be made about the relative transfer of sensorimotor learning of mentally handicapped and intellectually normal subjects with similar mental ages.

H_7: The mean performance of mentally handicapped subjects in the transfer of rote learning does not differ significantly from that of intellectually normal subjects with similar mental ages.

Table 13 is composed of data obtained in the trend analyses of the mean performance of the control and experimental groups of subjects on the 54 trials of the transfer series of the paired associates task. The between trials F ratios included in Table 13 reveal that the slope of the lines connecting the trial means of the retarded and normal subgroups of subjects showed highly significant deviations from zero over certain of the trials. According to the pictorial evidence included in Figures 9 and 10 these deviations took the form of rising curves. There was a slight difference

TABLE 13

TREND ANALYSES OF PERFORMANCE ON THE TRANSFER SERIES OF THE PAIRED ASSOCIATES TASK

	Source	df	SS	MS	F
Total Trials:RC-RE	Between groups	1	29.33	29.33	1.771
	Error (b)	28	463.98	16.56	
	Between trials	53	457.91	8.654	20.13***
	T x G	53	83.53	1.579	3.672***
	Error (w)	1,484	637.89	.430	
First Section:RC-RE	Between groups	1	77.82	77.82	14.31***
	Error (b)	28	152.45	5.44	
	Between trials	17	143.12	8.42	17.01***
	T x G	17	17.48	1.03	2.08**
	Error (w)	476	235.68	.495	
Second Section:RC-RE	Between groups	1	3.58	3.58	
	Error (b)	28	245.12	8.75	
	Between trials	17	10.52	.619	1.56
	T x G	17	8.89	.523	1.32
	Error (w)	476	188.48	.396	
Third Section:RC-RE	Between groups	1	1.78	1.78	
	Error (b)	28	169.52	6.05	
	Between trials	17	7.35	.432	1.86*
	T x G	17	3.32	.195	
	Error (w)	476	110.61	.232	

TABLE 13--Continued

	Source	df	SS	MS	F
Total Trials:NC-NE	Between groups	1	113.61	113.61	34.754^{***}
	Error (b)	28	91.56	3.269	
	Between trials	53	500.40	9.443	37.772^{***}
	T x G	53	77.29	1.458	5.832^{***}
	Error (w)	1,484	371.37	.250	
First Section:NC-NE	Between groups	1	131.03	131.03	44.237^{***}
	Error (b)	28	82.96	2.962	
	Between trials	17	191.22	11.244	26.900^{***}
	T x G	17	16.17	.951	2.275^{**}
	Error (w)	476	199.17	.418	
Second Section:NC-NE	Between groups	1	34.25	34.25	21.609^{**}
	Error (b)	28	44.41	1.585	
	Between trials	17	10.17	.598	2.875^{**}
	T x G	17	7.69	.452	2.173^{**}
	Error (w)	476	98.92	.208	
Third Section:NC-NE	Between groups	1	1.35	1.35	2.206
	Error (b)	28	17.13	.612	
	Between trials	17	.42	.0247	
	T x G	17	.41	.0241	
	Error (w)	476	20.34	.0427	

*Significant at less than the .05 level

**Significant at less than the .01 level

***Significant at less than the .001 level

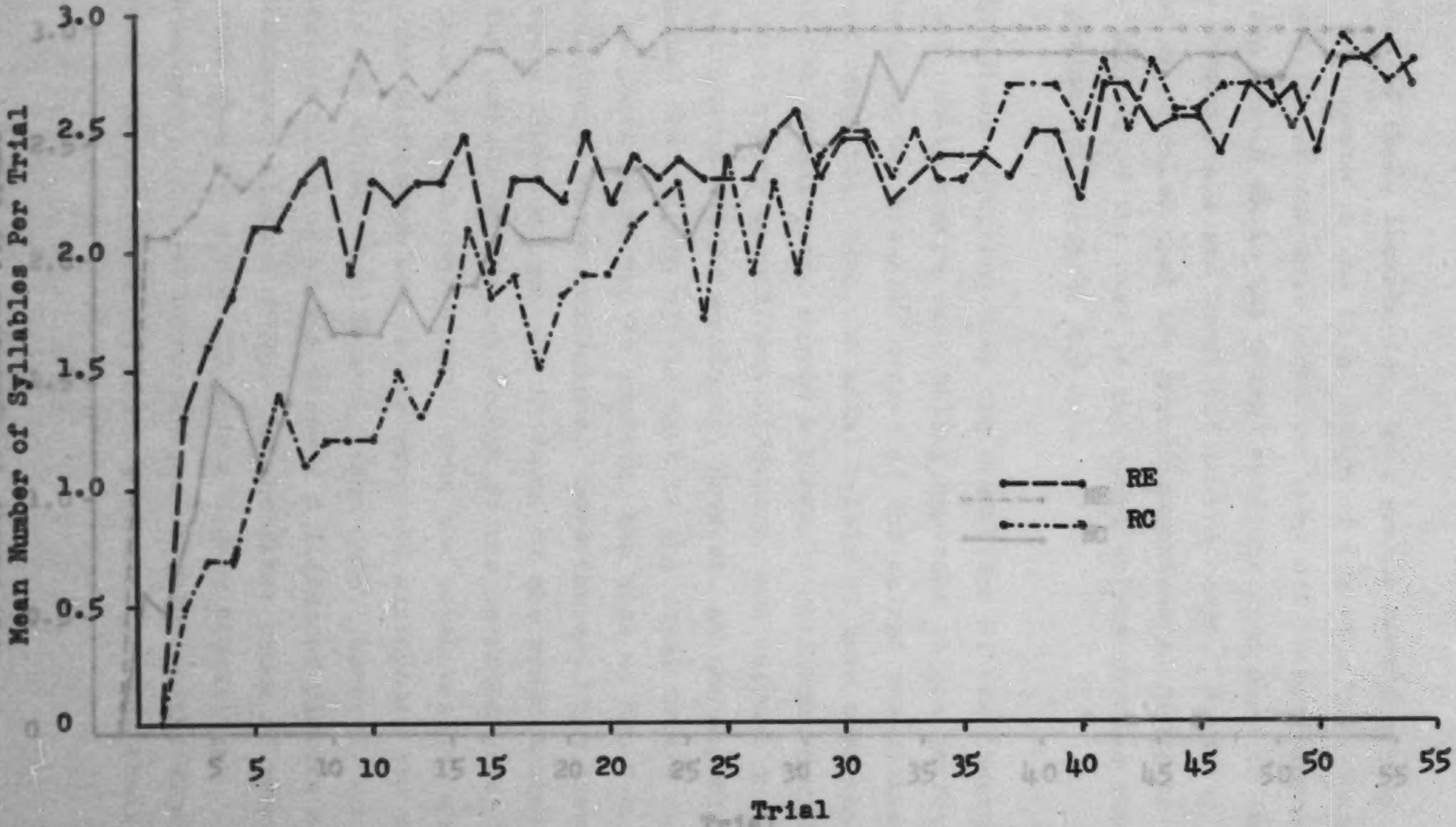


Fig. 9. Curves describing the performance of the retarded experimental and control subjects on the transfer series of the paired associates task.

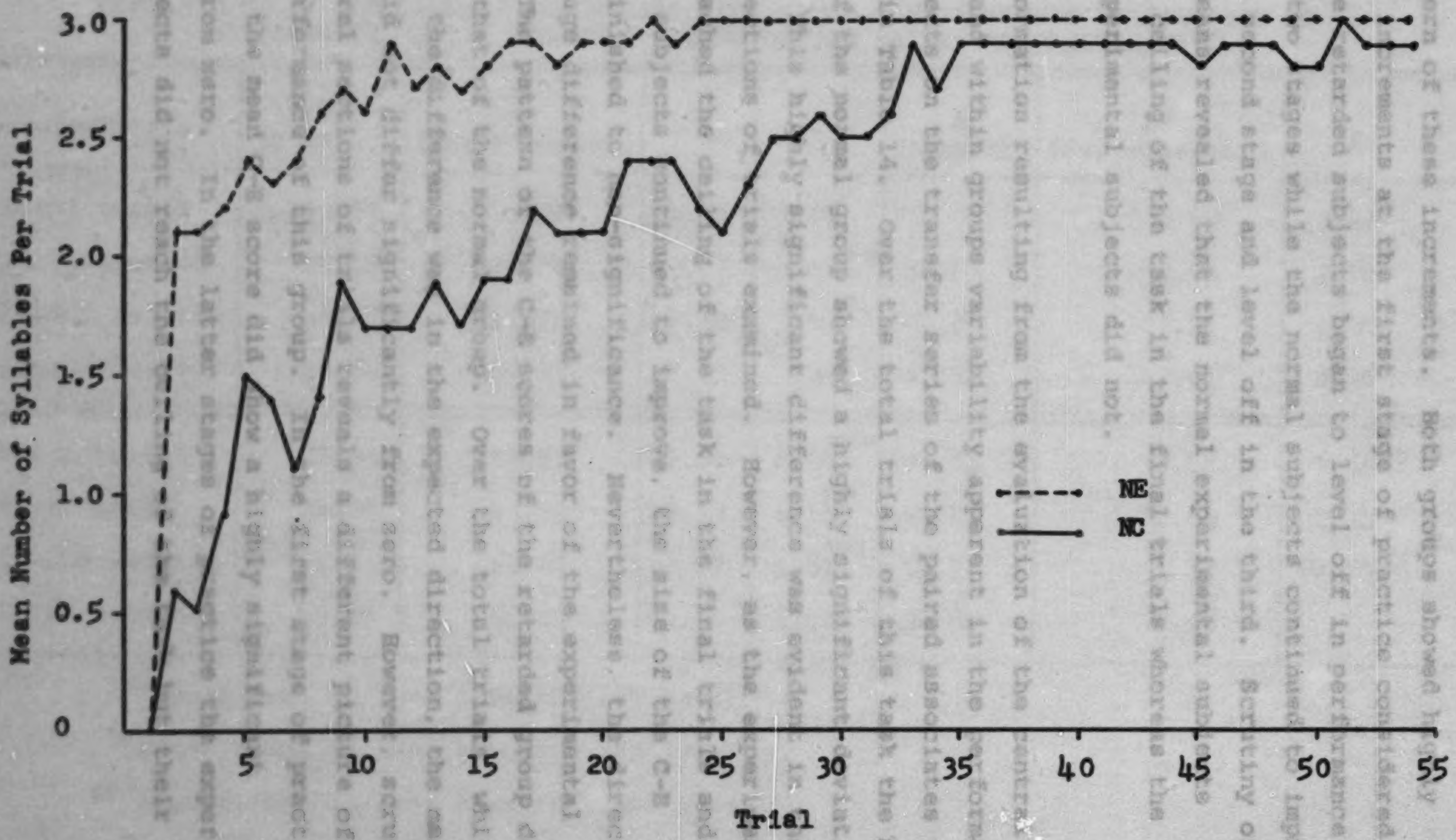


Fig. 10. Curves describing the performance of the normal experimental and control subjects on the transfer series of the paired associates task.

in the pattern of these increments. Both groups showed highly significant increments at the first stage of practice considered. However, the retarded subjects began to level off in performance at the latter two stages while the normal subjects continued to improve through the second stage and level off in the third. Scrutiny of the trial means revealed that the normal experimental subjects reached the ceiling of the task in the final trials whereas the retarded experimental subjects did not.

Information resulting from the evaluation of the central tendencies and within groups variability apparent in the performance of the subjects on the transfer series of the paired associates task is located in Table 14. Over the total trials of this task the mean C-E value of the normal group showed a highly significant deviation from zero. This highly significant difference was evident in the first two sections of trials examined. However, as the experimental subjects reached the ceiling of the task in the final trials and the control subjects continued to improve, the size of the C-E measure diminished to non-significance. Nevertheless, the direction of the average difference remained in favor of the experimental subjects. The pattern of the C-E scores of the retarded group differed from that of the normal group. Over the total trials, while the sign of the difference was in the expected direction, the mean C-E score did not differ significantly from zero. However, scrutiny of the several sections of trials reveals a different picture of the transfer performance of this group. In the first stage of practice considered, the mean C-E score did show a highly significant deviation from zero. In the latter stages of practice the experimental subjects did not reach the ceiling of the task but their

TABLE 14

COMPARISONS OF THE CENTRAL TENDENCIES AND OF THE WITHIN GROUPS VARIABILITY IN PERFORMANCE ON THE TRANSFER SERIES OF THE PAIRED ASSOCIATES TASK

Groups-Trials		$\overline{X}$ (Control)	$\overline{X}$ (Experimental)	D	t	s^2 (Control)	s^2 (Experimental)	F
RC-RE	Total trials	110.53	125.06	14.53	1.21	374.01	1,294.63	3.46^{*}
	First section	22.13	35.80	13.67	3.694^{**}	48.87	133.90	2.74
	Second section	39.87	42.80	2.93	.610	86.38	207.76	2.40
	Third section	48.53	46.47	2.07	.47	62.59	140.64	2.25
NC-NE	Total trials	122.93	151.53	28.60	6.085^{***a}	290.84	38.48	7.55^{**}
	First section	26.20	43.93	17.73	6.640^{***}	67.82	31.63	2.14
	Second section	44.53	53.60	9.07	4.85^{***a}	52.51	.77	68.19^{**}
	Third section	52.20	54.00	1.80	1.488	20.54	0.00	

[*] Significant at less than the .05 level

[**] Significant at less than the .01 level

[***] Significant at less than the .001 level

[a] Degrees of freedom equal 7

performance did level off. On the other hand, the control subjects continued to improve. As a result, the average difference in the second section of trials was attenuated to non-significance even though the sign of this difference remained in favor of the experimental subjects. In the final section of trials the control subjects, on the average, had slightly higher scores than did the experimental subjects. In terms of within groups variability the retarded control subjects were more homogeneous than the retarded experimental subjects throughout the trials; however, the ratio of the variances was large enough to be significant only in the total trials comparisons. On the other hand, while the normal experimental subjects showed less variability, the subgroups remained homogeneous until the latter sections of trials in which the experimental subjects began to reach the ceiling of the task.

On the basis of these data it seems safe to infer that both the retarded and normal subjects showed a highly significant amount of learning and transfer of learning in the initial stages of practice on the paired associates transfer task. The normal subjects continued in this trend during the second stage of practice considered, but the retarded subjects tended to level off in terms of both types of performance. In the final trials neither group exhibited an appreciable amount of learning or transfer.

In Table 15 are the results of the analyses of the mean C-E scores which reflect the relative transfer performance of the retarded and normal subjects on the paired associates task. At the first section of trials, where both showed a highly significant amount of learning and transfer, there was no significant difference between the means of the C-E scores. At the second stage of

TABLE 15

COMPARISONS OF THE CENTRAL TENDENCIES IN THE C-E SCORES ON THE TRANSFER SERIES OF THE PAIRED ASSOCIATES TASK

Trials	$\bar{X}$ (Retarded)	$\bar{X}$ (Normal)	$\bar{D}$	t
Total trials	14.53	28.60	14.07	1.312[a]
First section	13.67	17.73	4.06	1.088
Second section	2.93	9.07	6.14	1.49
Third section	2.07	1.80	-3.87	.921

[a] Degrees of freedom in all comparisons equal 7.

practice, where the learning and transfer indices of the retarded subjects were not quite large enough to be significant, the mean C-E scores of the normal subjects still did not deviate significantly from those of the retarded subjects. Thus, hypothesis 7 is supported. It seems safe to conclude that mentally handicapped and intellectually normal subjects of similar mental age do not differ in mean transfer of rote learning as it is reflected by the paired associates task employed in this investigation.

> H_8: The mean performance of mentally handicapped subjects in the transfer of a previously discovered principle does not differ significantly from that of intellectually normal subjects with similar mental ages.

The data obtained from the trend analyses of the subjects' performance on each of the 15 transfer trials of the principle task appear in Table 16. On the basis of these data there is reason to believe that over the total trials the slope of the lines connecting

TABLE 16

TREND ANALYSES OF PERFORMANCE ON THE TRANSFER SERIES OF THE PRINCIPLE TASK

	Source	df	SS	MS	F
Total Trials:RC-RE	Between groups	1	12.84	12.84	7.79*
	Error (b)	28	46.15	1.648	
	Between trials	14	4.19	.299	1.94*
	T x G	14	3.96	.283	1.84*
	Error (w)	392	60.38	.154	
First Section:RC-RE	Between groups	1	8.17	8.17	11.36*
	Error (b)	28	20.13	.719	
	Between trials	4	1.00	.25	1.03
	T x G	4	1.13	.283	1.17
	Error (w)	112	27.07	.242	
Second Section:RC-RE	Between groups	1	4.86	4.86	5.65
	Error (b)	28	24.08	.860	
	Between trials	4	.44	.110	
	T x G	4	.71	.178	1.46
	Error (w)	112	13.65	.122	
Third Section:RC-RE	Between groups	1	1.31	1.31	2.84
	Error (b)	28	12.93	.462	
	Between trials	4	.31	.078	1.01
	T x G	4	.62	.155	2.00
	Error (w)	112	8.67	.0774	

TABLE 16--Continued

	Source	df	SS	MS	F
Total Trials:NC-NE	Between groups	1	13.52	13.52	10.65*
	Error (b)	28	35.67	1.27	
	Between trials	14	4.72	.337	2.067*
	T x G	14	2.82	.201	1.233
	Error (w)	392	64.06	.163	
First Section:RC-RE	Between groups	1	6.82	6.82	8.06*
	Error (b)	28	23.71	.846	
	Between trials	4	1.53	.383	1.92
	T x G	4	.98	.245	1.23
	Error (w)	112	22.29	.199	
Second Section:NC-NE	Between groups	1	4.86	4.86	10.52*
	Error (b)	28	12.93	.462	
	Between trials	4	1.22	.305	2.19
	T x G	4	.78	.195	1.40
	Error (w)	112	15.60	.139	
Third Section:NC-NE	Between groups	1	2.40	2.40	4.61
	Error (b)	28	14.59	.521	
	Between trials	4	.49	.123	1.30
	T x G	4	.50	.125	1.32
	Error (w)	112	10.61	.0947	

*Significant at less than the .05 level

the trial means showed a significant deviation from zero in both the retarded and normal subgroups comparisons. These deviations took the form of falling curves (Figures 11 and 12). In no case were significant between trials F ratios obtained when performance over the smaller sections of trials was analyzed.

In Table 17 are found the results of the comparative analyses of the central tendency and within groups variability evident in performance on the transfer series of the principle task. The evaluation of transfer performance over the total trials indicated that the mean C-E scores of both groups deviated significantly from zero. These differences were evident in the first section of trials considered. In the second section of trials the normal mean C-E score was barely significant, while that of the retarded group was not quite so. In the third section of trials neither group had significant mean C-E scores. In all sections of trials scrutinized the groups showed marked heterogeneity of variance. Both the retarded and the normal experimental subjects manifested less variability than the corresponding control subjects.

These data seem to warrant the inference that both groups of subjects showed a significant amount of learning and transfer of learning over the total trials of the principle task. The learning was not manifested when the smaller sections of trials were considered. The transfer was evident during the initial trials but not the final trials of the task.

Evidence bearing on the relative mean transfer performance of the groups on the principle task is presented in Table 18. The difference between the mean C-E scores of the retarded and normal groups over the total trials was not significant. Neither was there a non-chance difference between these values at the first

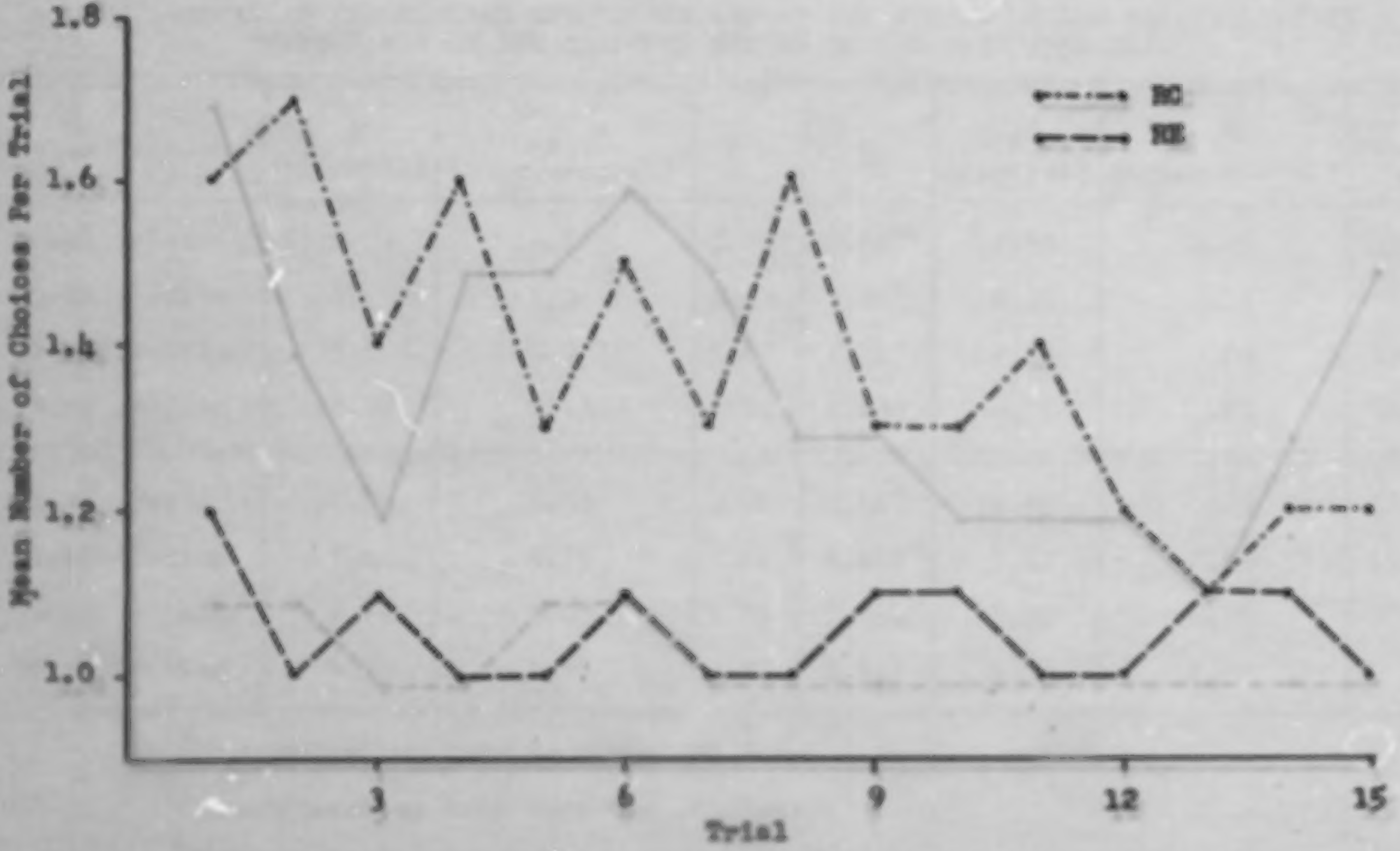


Fig. 11. Curves describing the performance of the retarded experimental and control subjects on the transfer series of the principle task.

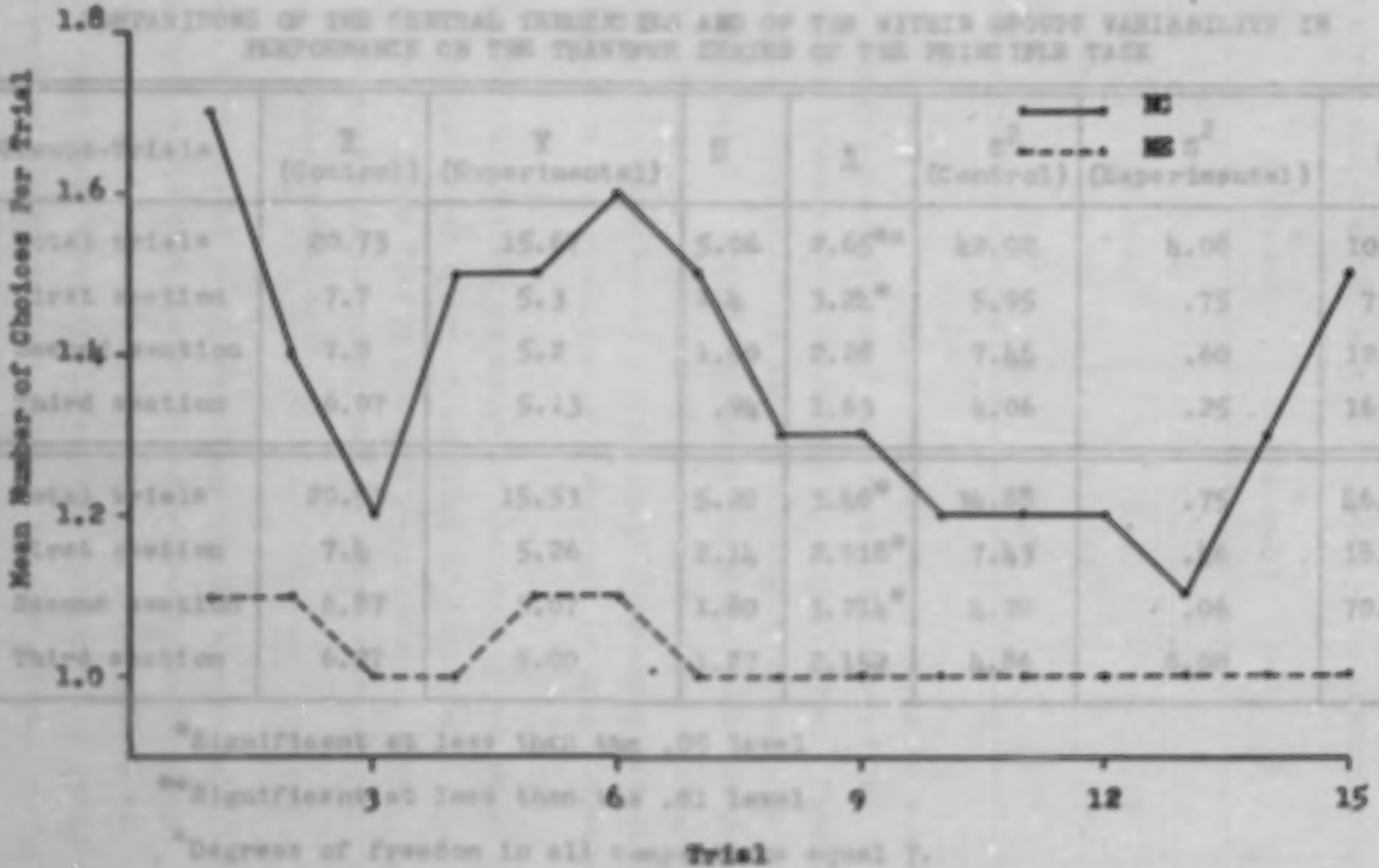


Fig. 12. Curves describing the performance of the normal experimental and control subjects on the transfer series of the principle task.

TABLE 17

COMPARISONS OF THE CENTRAL TENDENCIES AND OF THE WITHIN GROUPS VARIABILITY IN PERFORMANCE ON THE TRANSFER SERIES OF THE PRINCIPLE TASK

Groups-Trials		$\bar{X}$ (Control)	$\bar{X}$ (Experimental)	$\bar{D}$	t	s^2 (Control)	s^2 (Experimental)	F
N-N	Total trials	20.73	15.67	5.06	2.65**	42.02	4.08	10.29**
	First section	7.7	5.3	2.4	3.24*	5.95	.75	7.90**
	Second section	7.0	5.2	1.80	2.28	7.46	.60	12.43**
	Third section	6.07	5.13	.94	1.63	4.06	.25	16.24**
M-M	Total trials	20.53	15.53	5.20	3.40*	34.88	.75	46.51**
	First section	7.4	5.26	2.14	2.918*	7.43	.46	16.10**
	Second section	6.87	5.07	1.80	3.214*	4.20	.06	70.00**
	Third section	6.27	5.00	1.27	2.152	4.86	0.00	

*Significant at less than the .05 level

**Significant at less than the .01 level

[a]Degrees of freedom in all comparisons equal 7.

TABLE 18

COMPARISONS OF THE CENTRAL TENDENCIES IN THE C-E SCORES ON THE TRANSFER SERIES OF THE PRINCIPLE TASK

Trials	$\overline{X}$ (Retarded)	$\overline{X}$ (Normal)	$\overline{D}$	*t*
Total trials	5.06	5.21	.15	.0494
First section	2.33	2.13	.20	.192
Second section	1.80	1.80	0.00	
Third section	.93	1.27	.34	.347

section of trials where the major portion of the transfer manifested by the two groups occurred nor at the final sections of trials where the very little transfer was exhibited by either group. Therefore, hypothesis 8 is supported. It seems justifiable to conclude that mentally handicapped and intellectually normal subjects of comparable mental ages do not differ significantly in terms of mean performance in the transfer of a previously discovered principle as it is reflected by the principle task employed in this investigation.

H_9: The variability of mentally handicapped subjects in the three types of transfer of learning performance does not differ significantly from that of intellectually normal subjects with similar mental ages.

Table 19 includes information concerning the variability of the C-E indices derived from the subjects' performance on the transfer series of the paired associates and principle tasks. It is apparent from inspection of these data that on the principle task the retarded group generally tended to show greater within groups variability in C-E scores than the normal group.

TABLE 19

COMPARISONS OF THE WITHIN GROUPS VARIABILITY IN C-E SCORES ON THE TRANSFER SERIES OF THE PAIRED ASSOCIATES AND PRINCIPLE TASKS

Task-Trials		s^2 (Retarded)	s^2 (Normal)	F
Paired Associates	Total trials	2,008.11	313.97	6.39**
	First section	204.75	99.53	2.06
	Second section	334.06	49.12	6.80**
	Third section	268.46	20.56	13.06**
Principle Task	Total trials	3.40	2.18	1.56
	First section	7.15	7.45	1.04
	Second section	8.83	4.29	2.06
	Third section	4.59	4.86	1.06

**Significant at less than the .01 level

Nevertheless, in no case were these differences in homogeneity significant. The same relationship was maintained throughout the paired associates task. However, with one exception, the differences in variability on this task were highly significant. The one exception occurred in the first section of trials considered. Here, even though the retarded subjects showed more variation, the difference was not reliable.

It will be recalled that while both groups showed a significant amount of learning on the card sorting transfer task, neither group showed a significant amount of transfer of learning. As a result, no general statement can be made about the variability in transfer of sensorimotor learning. On the other hand, a significant amount of learning and transfer of learning did occur on the principle task but the subjects did not differ in terms of variability in transfer performance. At the one stage of practice on the paired associates task where both groups showed a highly significant amount of learning and transfer of learning, the subjects did not differ in variability in the transfer of learning. On the basis of these observed relationships it seems possible to conclude that where transfer of learning occurred, the groups did not differ markedly in terms of the variability of that transfer. However, since only transfer of rote learning and a previously discovered principle was demonstrated, hypothesis 9 is only partially supported.

CHAPTER IV

SUMMARY AND CONCLUSIONS

There was identified in Chapter I a need for further study of the relative intellectual characteristics of mentally handicapped and intellectually normal children with similar mental ages. The results of past investigations indicate that such children show certain similarities and differences in response to academic achievement and psychometric tests. It is possible to cite several factors which may be concomitant with these experimentally observed characteristics. The present study represented an extension of the earlier work in this area in the sense that an attempt was made to seek some evidence pertaining to certain of these related factors. Specifically, it was the intent of this investigation to inquire whether some of the relationships observed in the comparative studies of relative psychometric and achievement test performance were reflected in direct learning and transfer of learning performance.

Selected for subjects were 30 intellectually normal and 30 mentally handicapped boys who were matched individually on the basis of mental ages within the range of 7 years 11 months to 11 years 8 months. The mean mental age of both groups of subjects was 10 years 0 months. The normal subjects had a mean chronological age of 10 years 2 months; the retarded subjects, 15 years 0 months. The mean intelligence quotients of the two groups of subjects were 99 and 70 respectively. In order to meet the requirements of the transfer design the total normal and retarded groups both were divided into experimental and control subgroups of subjects who were matched individually on the basis of mental age, chronological age, and intelligence quotient.

The three tasks, designated as the card sorting, paired associates, and principle tasks, were assumed, in turn, to reflect sensorimotor learning, rote learning, and the discovery and application of an underlying principle. Each task consisted of two forms: a training form and a transfer form. The type of responses required by the two forms of a task remained identical; the stimuli were varied along a dimension of similarity. The training form of each task was administered to the retarded and normal experimental subgroups of subjects. The transfer form was administered to all four subgroups.

The data reported in previous comparative investigations of the response of retarded and normal subjects to various intellectual situations suggest that the nature of the observed similarities and differences in performance is a function of the type of intellectual activity involved and the aspect of performance being studied. On the basis of these data and certain *a priori* considerations hypotheses were proposed about the relative direct learning and transfer of learning performance of mentally handicapped and intellectually normal subjects with similar mental ages.

With three exceptions these hypotheses were fully supported by the results of the analyses of the data obtained in the administration of the tasks employed in this investigation. The first exception involved mean rote learning performance. Here the hypothesis was partially supported. The second exception was in mean performance in discovering a principle. There was no support for this hypothesis. The third exception pertained to the transfer of sensorimotor learning. Since the participating subjects did not show a significant amount of transfer of learning on the card sorting task, it was not possible to evaluate the hypotheses about relative mean performance and variability. Thys, the obtained data appear to justify the following conclusions.

1. The mean performance of mentally handicapped subjects in direct sensorimotor learning is significantly superior to that of intellectually normal subjects with similar mental ages.
2. The mean performance of intellectually normal subjects in direct rote learning is probably superior to that of mentally handicapped subjects with similar mental ages.
3. The variability of mentally handicapped subjects in the three types of direct learning performance--sensorimotor learning, rote learning, and the discovery of a principle--does not differ significantly from that of intellectually normal subjects with similar mental ages.
4. The rate of learning of mentally handicapped subjects in the three types of direct learning performance--sensorimotor learning, rote learning, and the discovery of a principle--does not differ significantly from that of intellectually normal subjects with similar mental ages.

5. The mean performance of mentally handicapped subjects in the transfer of rote learning does not differ significantly from that of intellectually normal subjects with similar mental ages.
6. The mean performance of mentally handicapped subjects in the transfer of a previously discovered principle does not differ significantly from that of intellectually normal subjects with similar mental ages.
7. The variability of mentally handicapped subjects in the transfer of rote learning does not differ significantly from that of intellectually normal subjects with similar mental ages.
8. The variability of mentally handicapped subjects in the transfer of a previously discovered principle does not differ significantly from that of intellectually normal subjects with similar mental ages.

These generalizations are limited to the populations from which the samples were selected and the types of learning performance assessed under the conditions of this investigation. A wider application will have to await subsequent study of other populations of children. In addition, there is need for further evaluation of the hypotheses proposed here by investigations in which are employed larger samples, different tasks which reflect the same types of direct learning and transfer of learning considered, and different experimental conditions. There is also a need for further comparative research on other psychological processes such as discrimination learning, conditioning, forgetting, motivation, etc.

When such studies are completed, special educators will have a more experimentally adequate psychological foundation to weigh with philosophical and sociological considerations in their curricular and methodological planning for mentally handicapped children. At the present time it is doubtful that a sufficient amount of such knowledge is available. It is considered that the present study makes a contribution in that direction. Nevertheless, the fund of information is still too incomplete and fragmentary to suggest well-founded implications for education. However, should they be sustained by further comparative research, the relationships demonstrated here do suggest that no a priori expectations about intellectual performance should be made on the basis of mental age alone. Instead, it is necessary to weigh both intelligence level and chronological age in relationship to mental age, the task, and the aspect of performance under consideration. Mentally handicapped individuals can be expected to perform more adequately, less adequately, or in a similar fashion to their intellectually normal mental age counterparts depending upon the type of response required by the situation in question.

Title: A Comparative Study of the Performance of Intellectually Retarded and Normal Boys on Selected Tasks Involving Learning and Transfer of Learning (USOE/127)

Investigator: William M. Cruickshank

Institution: Syracuse University, Syracuse, New York

Starting Date: December, 1956

Closing Date: December, 1957

PROBLEM

~~To study~~ the responses of educable mentally retarded children and intellectually normal children of similar mental ages to tasks involving certain aspects of learning and transfer of that learning. were studied

MAJOR OBJECTIVE

The major objective was To test the hypothesis that differences in achievement and intelligence test performances between the two groups tested are related to differences in the progress they make in learning and transfer.

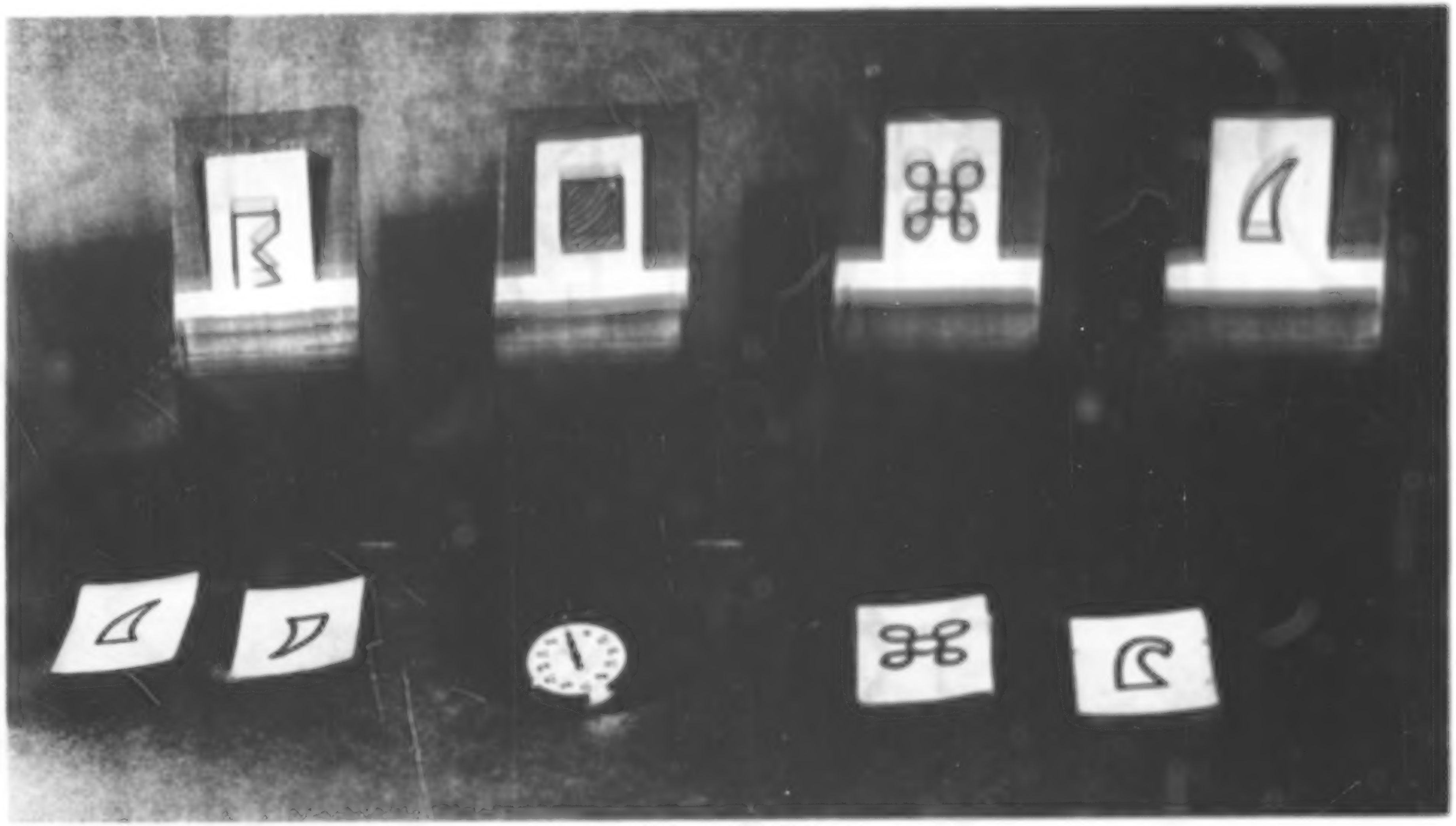
PROCEDURES AND DESIGN

Thirty mentally retarded endogenous boys within the I.Q. range of fifty to seventy-five and thirty boys within a normal I.Q. range (100-115) ~~will be~~ WERE matched individually on the basis of Binet mental age (8,9, and 10 years inclusive). The mentally retarded group ~~will be~~ WERE selected from the Syracuse State School; the normal boys, from an institutional setting. In addition to the determination of the I.Q. by individual assessment, each subject ~~will be~~ was screened for academic achievement, adequate vision and hearing, etc. The significance of any differences between the groups in mental age ~~will be~~ was evaluated by means of the t test. A series of tests, including such items as card sorting, paired associates, ~~will~~ furnished data for the study in evaluating performances of the subjects.

APPENDICES

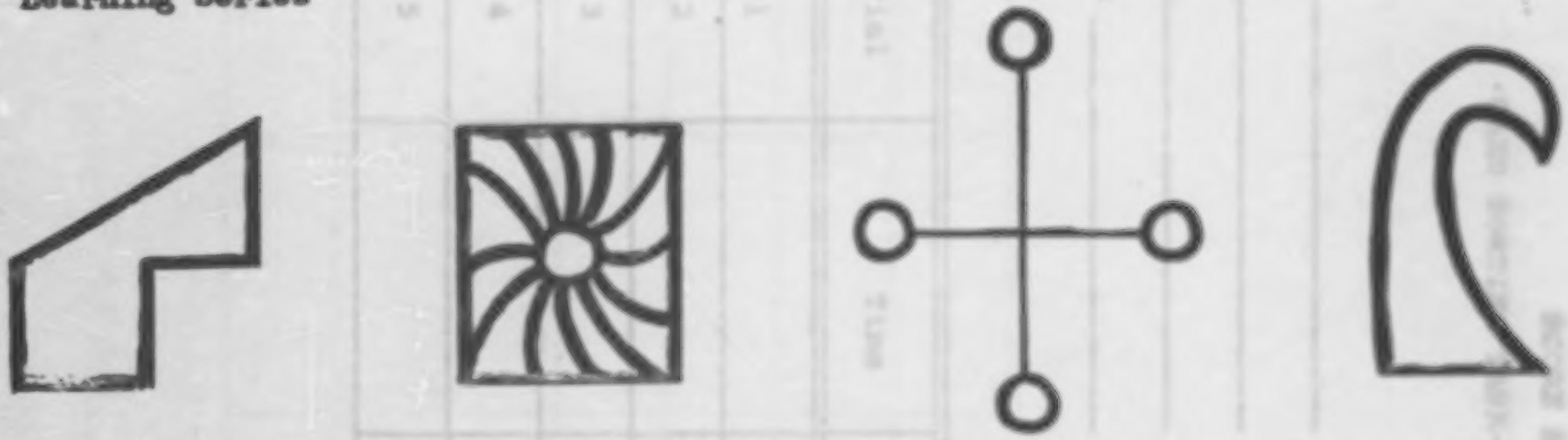
APPENDIX A

MATERIALS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE CARD SORTING TASK

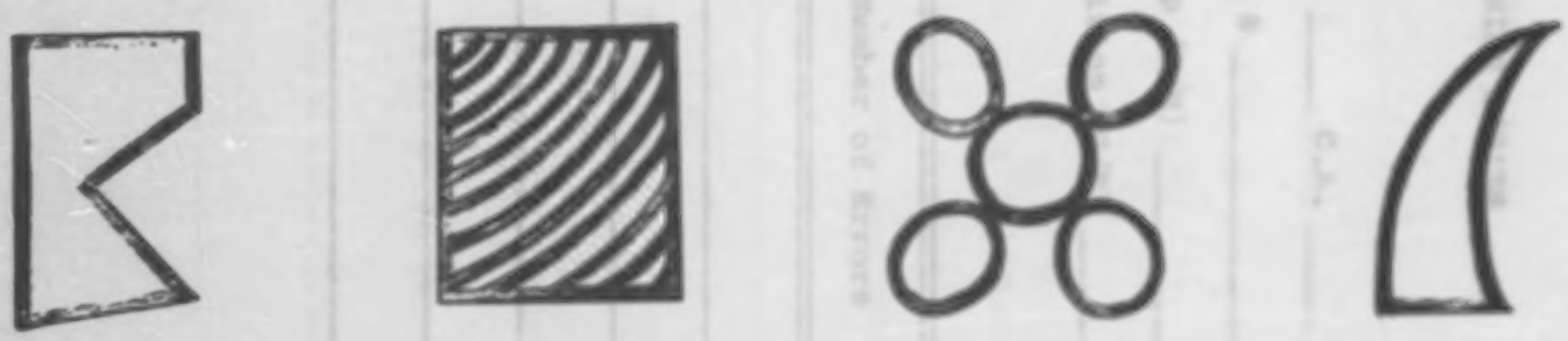


Apparatus--Card Sorting Task

A. Learning Series



B. Transfer Series



Designs Employed in the Learning and Transfer Series of the Card Sorting Task

SCORE SHEET
CARD SORTING TASK--LEARNING SERIES

Name ______________________ M.A. ____ C.A. ____ I.Q. ____

Date ______________________ Pair # ______________________

School ______________________ Group (R/N) ______________________

Institution ______________________ Condition (C/E) ______________________

Trial	Time	Number of Errors
1		
2		
3		
4		
5		

SCORE SHEET

CARD SORTING TASK--TRANSFER SERIES

Name ______________________ **M.A.** ____ **C.A.** ____ **I.Q.** ____

Date ______________________ **Pair #** ______________________

School ______________________ **Group (R/N)** ______________________

Institution ______________________ **Condition (C/E)** ______________________

Trial	Time	Number of Errors
1		
2		
3		
4		
5		
6		

APPENDIX B

DIRECTIONS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE CARD SORTING TASK

Learning Series

Do you like to play cards? Well, we have a slightly different kind of card game here. See these cards (show back of demonstration cards). They look like any other cards, don't they? But they are different in a way too. The picture on the front is probably different from any other picture you've ever seen before. See, there are four different kinds of pictures. Now here are four little boxes. Look on the lid on the back of each box. There is a picture fastened there. The pictures on the four boxes are just like the four pictures I have in my hand. In this game you are supposed to put each picture in the right box and the right box is the one which has the same picture on it as the card.

See, this picture and this picture are the same so this card goes in this box. Now, look at this card. In which box does it go? That's right, the pictures are the same. In which box does this card go. That's right. So you put the card in the box that has the same picture on it.

Let's see you do it with these cards. (Eight practice cards.) Good, that's what you do and here's how you do it. I have here a watch that keeps time in seconds. Did you ever watch Beat the Clock on T.V? You know how people on that program try to beat the clock by doing things real fast. That's what I want you to do. I have here a whole deck of cards like the ones you just had. I want you to put these cards in the right boxes as fast as you can and I'll keep time with the stop watch. Sometimes you'll throw the card in the wrong box like this (demonstrate). That would be a mistake. But don't try to fix it by trying to take the card out of the wrong box and to put it into the right box. That would only slow you down and how fast you are is the thing we want to see. Try not to make mistakes because I'll count them, but don't worry about them because you won't make any after you have done this a few times. Are you ready? When I say go, start. Go!

(After one trial)

That was good. Now, let's take the cards out and I'll shuffle them while you rest and then we'll try it again. (After cards are shuffled begin trial 2.) Here are the cards. Get ready. Go! (Continue for five trials.)

Transfer Series

Experimental Group

Now let's play the card game with another pack of cards. Here is the deck of cards. (From this point on repeat the directions of the learning series using the material of the transfer series. Continue for six trials. Give a speed set at the beginning of each trial.)

Control Group

(Repeat the directions of the learning series using the material of the transfer series. Continue for six trials. Give a speed set at the beginning of each trial.)

APPENDIX C

MATERIALS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE PAIRED ASSOCIATES TASK

Apparatus--Paired Associates Task

Lists of nonsense syllables as they were prepared for placement on the memory drums.

Learning Series

****
****
bip juf
bip
kej pob
kej
zab rix
zab
****
****
****
kej pob
kej
zab rix
zab
bip juf
bip
****
****

****
****
zab rix
zab
bip juf
bip
kej pob
kej
****
****
****
zab rix
zab
kej pob
kej
bip juf
bip
****
****

Transfer Series

****
****
kaj pob
kaj
zub rix
zub
bep juf
bep
****
****
****
****
kaj pob
kaj
bep juf
bep
zub rix
zub
****
****

****
****
zub rix
zub
bep juf
bep
kaj pob
kaj
****
****
****
****
bep juf
bep
kaj pob
kaj
zub rix
zub
****
****

SCORE SHEET

PAIRED ASSOCIATES TASK--LEARNING SERIES

Name ____________________ M.A. ______ C.A. ______ I.Q. ______

Date ____________________ Pair # ____________________

School ____________________ Group (R/N) ____________________

Institution ____________________ Condition (C/E) ____________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
1				4				7			
juf				pob				juf			
rix				juf				pob			
pob				rix				rix			
Total				Total				Total			
2				5				8			
rix				juf				pob			
pob				rix				juf			
juf				pob				rix			
Total				Total				Total			
3				6				9			
juf				rix				juf			
pob				pob				rix			
rix				juf				pob			
Total				Total				Total			

Page 2

Paired Associates--Learning Series Name ______________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
10				15				20			
rix				juf				pob			
pob				pob				juf			
juf				rix				rix			
Total				Total				Total			
11				16				21			
juf				pob				juf			
pob				juf				rix			
rix				rix				pob			
Total				Total				Total			
12				17				22			
pob				juf				rix			
juf				rix				pob			
rix				pob				juf			
Total				Total				Total			
13				18				23			
juf				rix				juf			
rix				pob				pob			
pob				juf				rix			
Total				Total				Total			
14				19				24			
rix				juf				pob			
pob				pob				juf			
juf				rix				rix			
Total				Total				Total			

Page 3

Paired Associates--Learning Series

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
25				29				33			
juf				juf				juf			
rix				rix				rix			
pob				pob				pob			
Total				Total				Total			
26				30				34			
rix				rix				rix			
pob				pob				pob			
juf				juf				juf			
Total				Total				Total			
27				31				35			
juf				juf				juf			
pob				pob				pob			
rix				rix				rix			
Total				Total				Total			
28				32				36			
pob				pob				pob			
juf				juf				juf			
rix				rix				rix			
Total				Total				Total			

SCORE SHEET

PAIRED ASSOCIATES TASK--TRANSFER SERIES

Name ______________________ M.A. ________ C.A. _____ I.Q. _____

Date ______________________ Pair # ______________________

School ______________________ Group (R/N) ______________________

Institution ______________________ Condition (C/E) ______________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
1				4				7			
rix				pob				rix			
juf				juf				pob			
pob				rix				juf			
Total				Total				Total			
2				5				8			
juf				rix				pob			
rix				juf				juf			
pob				pob				rix			
Total				Total				Total			
3				6				9			
rix				juf				rix			
pob				rix				juf			
juf				pob				pob			
Total				Total				Total			

Page 2
Paired Associates--Transfer Series Name ______________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
10				15				20			
juf				rix				pob			
rix				pob				juf			
pob				juf				rix			
Total				Total				Total			
11				16				21			
rix				pob				rix			
pob				juf				juf			
juf				rix				pob			
Total				Total				Total			
12				17				22			
pob				rix				juf			
juf				juf				rix			
rix				pob				pob			
Total				Total				Total			
13				18				23			
rix				juf				rix			
juf				rix				pob			
pob				pob				juf			
Total				Total				Total			
14				19				24			
juf				rix				pob			
rix				pob				juf			
pob				juf				rix			
Total				Total				Total			

Page 3
Paired Associates--Transfer Series Name ____________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
25				30				35			
rix				juf				rix			
pob				rix				pob			
juf				pob				juf			
Total				Total				Total			
26				31				36			
juf				rix				pob			
rix				pob				juf			
pob				juf				rix			
Total				Total				Total			
27				32				37			
rix				pob				rix			
pob				juf				juf			
juf				rix				pob			
Total				Total				Total			
28				33				38			
pob				rix				juf			
juf				juf				rix			
rix				pob				pob			
Total				Total				Total			
29				34				39			
rix				juf				rix			
juf				rix				pob			
pob				pob				juf			
Total				Total				Total			

Page 4
Paired Associates--Transfer Series Name ____________________

Trial	R	W	O	Trial	R	W	O	Trial	R	W	O
40				45				50			
pob				rix				juf			
juf				juf				rix			
rix				pob				pob			
Total				Total				Total			
41				46				51			
rix				juf				rix			
juf				rix				pob			
pob				pob				juf			
Total				Total				Total			
42				47				52			
juf				rix				pob			
rix				pob				juf			
pob				juf				rix			
Total				Total				Total			
43				48				53			
rix				pob				rix			
pob				juf				juf			
juf				rix				pob			
Total				Total				Total			
44				49				54			
pob				rix				juf			
juf				juf				rix			
rix				pob				pob			
Total				Total				Total			

APPENDIX D

DIRECTIONS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE PAIRED ASSOCIATES TASK

Learning Series

Today we have a word game to play. But, before we look at it, I want to show you some of the words we'll be using so that you can learn to say them. These are kind of funny little words. They are not hard to say, but they are probably different from any words you've ever seen before. I'll say each word first and you say it after me. This word is "pob." Can you say "pob?" That's right. Now this word is "juf." You say it. That's right. Now this word is "rix." You say it. That's good. Now I'll mix the cards up and this time you say the words first. I'll help you if you need it. That's good. I'll mix up the cards and we'll go through them again. (Continue until the subject can say all of the words correctly two times.)

Now you know the words. Let's see how the game is played. This is a game of word partners. Word partners are two words which are always together. They are partners because they belong together. You'll see them on this machine. (Start memory drum.) Here is the first word of a pair of partners. Next you'll see it with its partner. Now the game is for you to learn who its partner is so that the next time you see it by itself you'll be able to say its partner's name. (Start memory drum.) Now here it is with its partner. (Stop memory drum.) What is its partner's name? That's right. Now the next time you see this word by itself (cover the response syllable and leave the stimulus syllable exposed) what will you say? That's right. You'll say its partner's name. Then when the two come together like this you can check to see if you are right. (Start memory drum.) Now let's look at the next set of word partners. (Stop memory drum.) Here is the first one of the pair of partners. Next you'll see it with its partner. (Continue through the three sets of paired associates.) Do you understand what to do? That's right. When you see the first word by itself you'll say its partner's name. Then when the two come together you can check to see if you are right.

There are two more things I want to tell you. First, next time I'm not going to keep stopping the machine like I did this time and the words will come before the window a little faster. So when you see the first word of a pair of partners you'll have to say its partner's name rather quickly. However, it won't seem so fast after a few times. Second, the word partners come in several different orders. Although the word partners are always the same, where the pair of words come in the list will change each time. So you just have to learn which words go together. Between each list there are four lines of stars (asterisks). After the fourth line you can expect the first word.

Are you ready to start the game? Remember, when you see the first word try to say its partner's name. Then when you see the two together you can check to see if you are right. Ready, watch the stars. Now, here's the first word. (Trial 2) (Stop memory drum.) That was good. Now rest a minute (thirty to forty-five seconds rest period). Let's go again (continue for 36 trials).

Transfer Series

Experimental Group

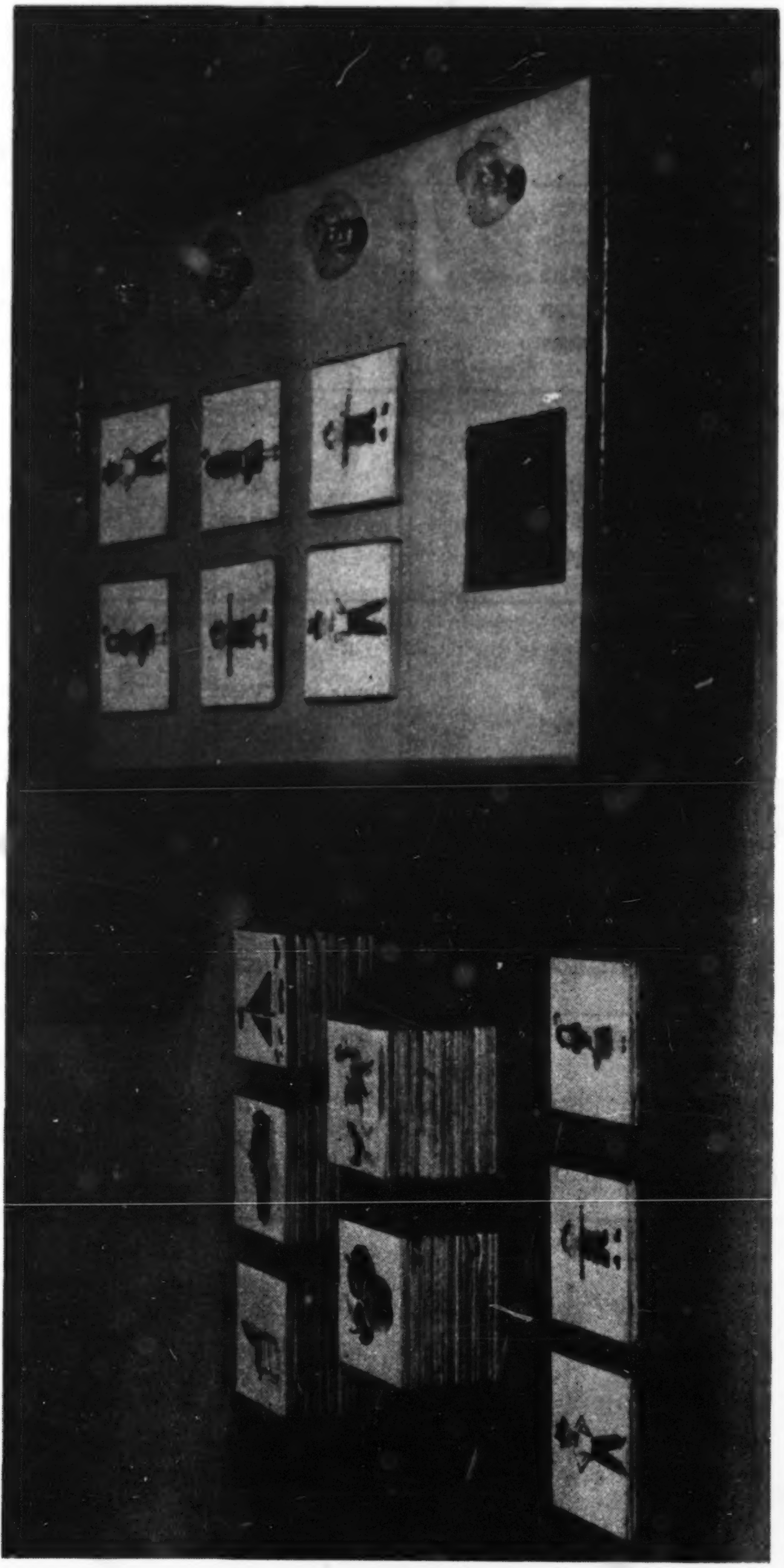
Now we have another list of word partners to learn. (From this point on repeat the directions of the learning series using the material of the transfer series. Continue for 54 trials.)

Control Group

(Repeat the directions of the learning series using the material of the transfer series. Continue for 54 trials.)

APPENDIX E

MATERIALS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE PRINCIPLE TASK



Apparatus--Principle Task

GUIDE SHEET--ARRANGEMENTS OF MATERIALS

PRINCIPLE TASK--LEARNING SERIES

	Trial 1	Boy			Trial 6	Woman	
woman	boy	+	woman	boy	woman	+	boy
boy	man	+	man	man	boy	-	man
man	woman	-	boy	woman	man	+	woman
	Trial 2	Man			Trial 7	Woman	
woman	man	+	man	man	boy	-	boy
boy	woman	-	woman	woman	man	+	woman
man	boy	+	boy	boy	woman	+	man
	Trial 3	Woman			Trial 8	Boy	
boy	man	-	boy	woman	man	-	man
man	woman	+	woman	boy	woman	+	boy
woman	boy	+	man	man	boy	+	woman
	Trial 4	Man			Trial 9	Man	
man	woman	+	woman	boy	woman	-	woman
woman	boy	-	boy	man	boy	+	man
boy	man	+	man	woman	man	+	boy
	Trial 5	Boy			Trial 10	Boy	
man	boy	+	man	boy	woman	+	boy
woman	man	-	boy	man	boy	+	man
boy	Woman	+	woman	Woman	man	-	woman

PRINCIPLE TASK--LEARNING SERIES - Continued

Trial 11	Woman			Trial 16	Woman		
man	woman	+	man	woman	man	+	man
woman	boy	+	woman	boy	woman	+	boy
boy	man	-	boy	man	boy	-	woman
Trial 12	Man			Trial 17	Man		
woman	boy	-	woman	man	boy	+	boy
boy	man	+	boy	woman	man	+	woman
man	woman	+	man	boy	woman	-	man
Trial 13	Man			Trial 18	Boy		
boy	man	+	woman	boy	man	+	woman
man	woman	+	boy	man	woman	-	man
woman	boy	-	man	woman	boy	+	boy
Trial 14	Woman			Trial 19	Boy		
woman	boy	+	boy	woman	man	-	man
boy	man	-	man	boy	woman	+	boy
man	woman	+	woman	man	boy	+	woman
Trial 15	Boy			Trial 20	Man		
man	woman	-	man	boy	man	+	woman
woman	boy	+	woman	man	woman	+	man
boy	man	+	boy	woman	boy	-	boy

GUIDE SHEET--ARRANGEMENTS OF MATERIALS

PRINCIPLE TASK--TRANSFER SERIES

Trial 1	Animals		Cat
cat	dog	+	horse
horse	cat	+	cat
dog	horse	-	dog

Trial 2	Toys		Ball
ball	car	+	ball
car	boat	-	car
boat	ball	+	boat

Trial 3	Clothes		Coat
shoe	hat	-	hat
hat	coat	+	shoe
coat	shoe	+	coat

Trial 4	Furniture		Chair
bed	chair	+	table
table	bed	-	chair
chair	table	+	bed

Trial 5	Fruit		Banana
orange	apple	-	banana
apple	banana	+	orange
banana	orange	+	apple

Trial 6	Toys		Boat
car	boat	+	car
boat	ball	+	car
ball	car	-	ball

Trial 7	Fruit		Apple
orange	banana	-	apple
apple	orange	+	banana
banana	apple	+	orange

Trial 8	Clothes		Hat
coat	hat	+	shoe
shoes	coat	-	hat
hat	shoes	+	coat

Trial 9	People		Woman
boy	man	-	boy
man	woman	+	man
woman	boy	+	woman

Trial 10	Animals		Dog
horse	cat	-	horse
dog	horse	+	cat
cat	dog	+	dog

PRINCIPLE TASK--TRANSFER SERIES - Continued

Trial 11	**Furniture**		**Table**	**Trial 16**	**Toys**		**Boat**
table	chair	+	chair	boat	car	+	car
chair	bed	-	table	ball	boat	+	boat
bed	table	+	bed	car	ball	-	ball
Trial 12	**People**		**Man**	**Trial 17**	**Animals**		**Cat**
boy	woman	-	boy	horse	dog	-	dog
man	boy	+	woman	dog	cat	+	cat
woman	man	+	man	cat	horse	+	horse
Trial 13	**Clothes**		**Coat**	**Trial 18**	**Furniture**		**Chair**
coat	shoes	+	shoe	chair	bed	+	bed
shoes	hat	-	coat	bed	table	-	table
hat	coat	+	hat	table	chair	+	chair
Trial 14	**Fruit**		**Banana**	**Trial 19**	**Animals**		**Dog**
apple	orange	-	orange	dog	horse	+	cat
banana	apple	+	banana	cat	dog	+	horse
orange	banana	+	apple	horse	cat	-	dog
Trial 15	**People**		**Boy**	**Trial 20**	**Toys**		**Car**
boy	woman	+	man	ball	car	+	boat
man	boy	+	boy	car	boat	+	ball
woman	man	-	woman	boat	ball	-	car

SCORE SHEET

PRINCIPLE TASK--LEARNING SERIES

Name ______________________ M.A. ______ C.A. ______ I.Q. ______

Date ______________________ Pair # ______________________

School ______________________ Group (R/N) ______________________

Institution ______________________ Condition (C/E) ______________________

Trial	R	W	P	Trial	R	W	P
1 (boy)				6 (woman)			
1				1			
2				2			
3				3			
Total				Total			
2 (man)				7 (woman)			
1				1			
2				2			
3				3			
Total				Total			
3 (woman)				8 (boy)			
1				1			
2				2			
3				3			
Total				Total			
4 (man)				9 (man)			
1				1			
2				2			
3				3			
Total				Total			
5 (boy)				10 (boy)			
1				1			
2				2			
3				3			
Total				Total			

Page 2
Principle Task--Learning Series Name ____________________

Trial	R	W	P	Trial	R	W	P
11 (woman)				16 (woman)			
1				1			
2				2			
3				3			
Total				Total			
12 (man)				17 (man)			
1				1			
2				2			
3				3			
Total				Total			
13 (man)				18 (boy)			
1				1			
2				2			
3				3			
Total				Total			
14 (woman)				19 (boy)			
1				1			
2				2			
3				3			
Total				Total			
15 (boy)				20 (man)			
1				1			
2				2			
3				3			
Total				Total			

SCORE SHEET

PRINCIPLE TASK--TRANSFER SERIES

Name ______________________________ **M.A.** ______ **C.A.** ______ **I.Q.** ______

Date ______________________________ **Pair #** ______________________

School ______________________________ **Group (R/N)** ______________________

Institution ______________________________ **Condition (C/E)** ______________________

	Trial	R	W	P	Trial	R	W	P
1	(cat)				6 (boat)			
	1				1			
	2				2			
	3				3			
	Total				Total			
2	(ball)				7 (apple)			
	1				1			
	2				2			
	3				3			
	Total				Total			
3	(coat)				8 (hat)			
	1				1			
	2				2			
	3				3			
	Total				Total			
4	(chair)				9 (boy)			
	1				1			
	2				2			
	3				3			
	Total				Total			
5	(banana)				10 (dog)			
	1				1			
	2				2			
	3				3			
	Total				Total			

Page 2
Principle Task--Transfer Series Name ______________________________

Trial	R	W	P	Trial	R	W	P
11 (table)				16 (boat)			
1				1			
2				2			
3				3			
Total				Total			
12 (man)				17 (cat)			
1				1			
2				2			
3				3			
Total				Total			
13 (coat)				18 (chair)			
1				1			
2				2			
3				3			
Total				Total			
14 (banana)				19 (dog)			
1				1			
2				2			
3				3			
Total				Total			
15 (woman)				20 (car)			
1				1			
2				2			
3				3			
Total				Total			

APPENDIX F

DIRECTIONS EMPLOYED IN THE ADMINISTRATION OF THE LEARNING AND TRANSFER SERIES OF THE PRINCIPLE TASK

Learning Series

Now we have a puzzle to figure out. But before we work on it I want to see whether you know the names of all of the parts. Here are some blocks with pictures on them. As I hand them to you, you tell me the name of each picture. What's this? That's right, it's a boy. (And so on through the set of pictures.) You see there are three of each kind of picture--3 boys, 3 men and 3 women. All three are just alike. And see the lights on this board. I can make them go on and off like this. (Demonstrate)

You know the names of all of the pictures so let's go on to the puzzle. I'm going to put two pictures in the first row. What are the names of these two pictures? That's right. . . a boy and a man. Is the light on or off? (on). Now the next row. Which pictures am I putting in this row? (man, woman). Is the light on or off? (off). What are the pictures that I'm putting in the third row? (woman, boy). Is the light on or off? (on).

Now here is the puzzle. You see there is only one space left but three extra pictures. The light is off, but we want to make it go on. Up here (indicate demonstration section) there is one picture making these lights go on. Only one picture can do it. The puzzle is to figure out which picture it is that's causing the lights to go on; when you do, choose it from these three extra pictures and put it in the empty space so the light will go on.

(If the wrong choice is made.) Well--that must not be the right picture because the light did not go on. Let's put that one back and you choose again. (if the second choice is incorrect--repeat--the third choice will be correct by the process of elimination.)

(When the correct choice is made.) The light is on so the boy must be the right one. To win the game you have to pick the right picture the first time you get a chance to choose. Now look at the pictures in the rows where the lights are on. Look at the pictures in the row where the light is off. Then tell me, "Why did you choose the boy?" (Alternate methods of asking for the principle are the following: Why was the boy right? Why did the boy make the light go on? Why did the light go on when the boy was put in this place?) (Designate principle as correct or incorrect on the score sheet. Make no comment.)

(After the subject has given an answer to the question, begin trial 2.) Now let's take these pictures out and work the puzzle again with the people put in a different way. (Continue for 15 trials. After trial 15 if the subject has not correctly stated the principle and made the correct selection on the first choice for 5 consecutive trials, give the following hint.)

Look at the pictures in the first row in which the light is on. Look at the picture in the row in which the light is not on. Point to the picture which is in both of the rows in which the light is on but not in the row in which the light is off. Now, why is the woman the right one to choose to make the light down here go on. (Continue to trial 20, repeating the hint on each trial until the subject correctly verbalizes the principle.)

Transfer Series

A. Experimental Group

Now, let's work the puzzle with some different pictures. But before we do, let's see if you know the names of all of the pictures we will be using. (From this point on repeat the directions of the learning series using the material of the transfer series. Do not ask for the principle or give hint. Continue for 15 trials.)

B. Control Group

(Repeat the directions of the learning series using the material of the transfer series. Do not ask for the principle or give hint. Continue for 15 trials.)

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